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THE WILSON BULLETIN

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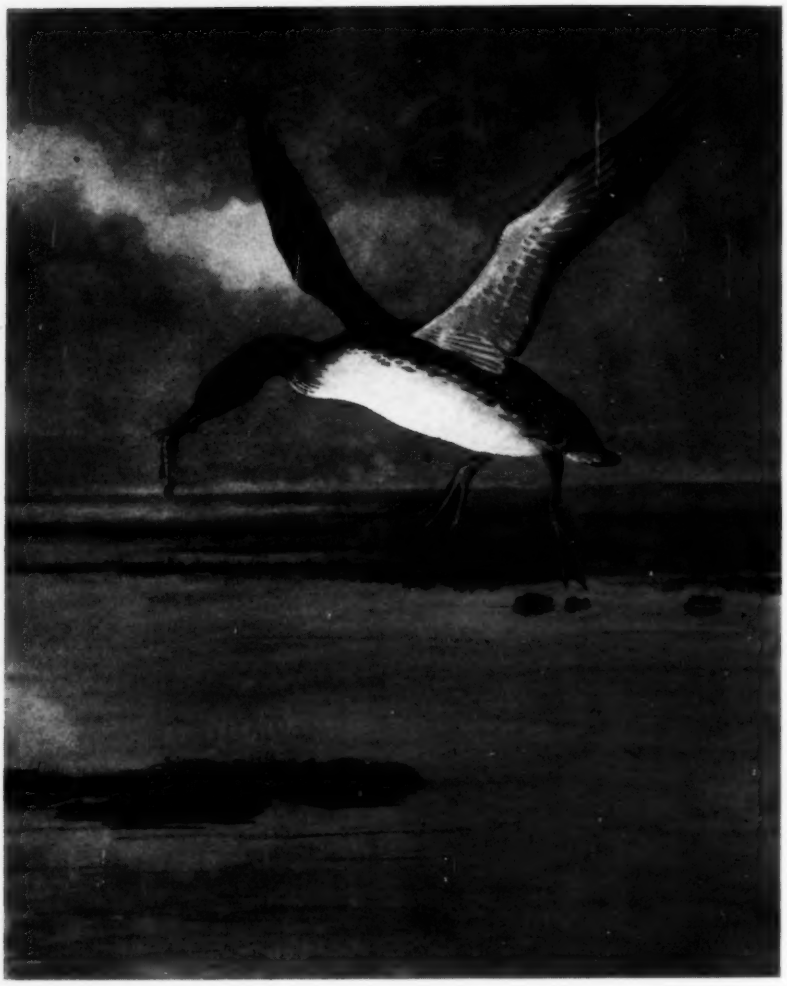

Southampton Island, 1929 *George Miksch Sutton del.*

RED-THROATED LOON BRINGING FOOD TO ITS YOUNG

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THE WILSON BULLETIN
A QUARTERLY MAGAZINE OF ORNITHOLOGY
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Vol. 55 SEPTEMBER, 1943 No. 3

THE WING MOLTS OF ADULT LOONS: A REVIEW OF THE EVIDENCE

BY GEORGE MIKSCH SUTTON

ADULT loons are generally believed to undergo two molts a year—a postnuptial and a prenuptial. Opinions differ as to whether both these molts are complete, however; and a careful comparison of published statements and examination of specimens has led me to suspect that there is but one really complete molt per year; that the so-called 'complete prenuptial molt', may be only a molting of body plumage concomitant with a much delayed 'postnuptial' molting of remiges; that certain individual loons may undergo a complete postnuptial molt on or near their breeding grounds, whereas other individuals may, as a result of delayed nidification, be obliged to move southward in full breeding dress; that, in short, the whole molting program may vary so greatly that, unless one can catch and mark a loon in the late summer flightless stage of the molt, and capture the same bird a few months later, again in a flightless stage of the molt, one has no way of being certain that an individual loon ever accomplishes a *complete* molt in late summer or fall, and another *complete* molt the following spring.

In the fall of 1929, while I was on Southampton Island, Hudson Bay, I was impressed with the fact that many young Red-throated Loons (*Gavia stellata*) and Pacific Loons (*Gavia arctica pacifica*) did not leave their nesting ponds until about the middle of September. One brood of young Red-throated Loons lingered as late as September 23, keeping a hole about 15 feet in diameter open in the ice (Sutton, 1932:20). Here the parent birds, which brought fish regularly from salt water a mile or so away, were obliged to alight and take off as best they could until the young birds were strong enough to fly to the sea.

When did those parent Red-throated Loons reach the flightless stage of their post-nuptial molt? Obviously not in the summer of 1929. They had to have their remiges *on them* all that summer. Their first set of eggs had been destroyed, perhaps by an Arctic fox, so their brood was late. Nor was their case exceptional. Many other pairs were as late as they. In their well ordered tundra world it was as

normal for them to be delayed as it was for the foxes and lemmings to be at or near a peak of abundance that year.

Those parent loons may have begun their postnuptial molt immediately after getting their young safely to sea. They may even have completed it before moving southward from Hudson Bay. But it would not surprise me to learn that they reached their wintering grounds in virtually complete breeding plumage, passed slowly into winter body plumage, and eventually completed this postnuptial molt by dropping their frayed, faded remiges about the time the prenuptial molting of the body feathers began. Witherby (Witherby *et al.*, 1940: 112 ff.), Bent (1919:47 ff.), and other writers make it quite clear that molting loons as well as loons in full breeding dress are found on the wintering grounds. A bird in new breeding plumage, with partly grown remiges, would certainly appear to be in the last stages of a complete prenuptial molt—that is obvious. What disturbs me is that we do not know that this same bird lost all its remiges the preceding fall. We are only guessing. It would be easy enough to discuss *the possibility* of two complete molts per year with a great series of molting specimens at hand; less easy to account for two molts; impossible to *prove*, from the specimens alone, that a given individual actually accomplishes them. Why should loons have them? Do loons need two sets of remiges per year while ducks, geese, and swans do not? Both groups are water birds, have the same body-temperature problems, much the same migration problems, near the same degree of feather wear; hence they might be expected to be clothed similarly. There is plenty of evidence to show that loons do go through a flightless period; no evidence, so far as I know (and I have examined loons in a good many collections), that they molt their wings feather by feather as hawks, for example, do. But the question is (as at the outset): Do they molt all the remiges at once, and hence become flightless, *twice* a year? Authors have been assuming too much: because flightless birds have been taken in the fall and also in the spring, they have assumed that all loons have two complete molts per year.

The loons are a small and homogeneous order. The fact that breeding range, general program of migration and nesting are much the same throughout the order makes it easy to believe that the four species molt similarly, though this is not necessarily the case. Let us see what various authors have to say about the molts of the four species of loons.

Gavia stellata. Bent (1919:77) states that adult Red-throated Loons have "two annual molts; a partial prenuptial molt, involving at least all of the feathers on the forepart of the body. . . . I have seen the beginning of this molt as early as December 28, but usually it is accomplished during March and April; and a complete postnuptial molt, during the latter part of the summer, produces the adult winter plumage [which] . . . is often not complete until late in the

season. I have seen birds in very much worn plumage and only partially molted in December; this plumage is worn for a comparatively short time and the molt into it is often incomplete and sometimes not accomplished at all. I have seen a bird in full spring plumage in October and another, in the same month, in regular winter plumage with the full, rich red throat of the nuptial plumage. Fall adults are scarce in collections and, if we had them in large series, we might be surprised to know to what extent old birds retain part or all of their spring plumage during the fall." Forbush (1925:28) says that adults "apparently have a complete prenuptial molt and a complete postnuptial molt." Witherby (Witherby *et al.*, 1940:127) says that the winter plumage is "acquired by complete moult Oct.–Dec. Primaries, primary-coverts and secondaries are moulted simultaneously but wing-coverts normally. . . . Another moult takes place March–May, ... but material is insufficient to decide if remiges are moulted again as in autumn."

As I have pointed out above, the Red-throated Loon's postnuptial molt is certainly not always a late summer phenomenon. Breeding birds get their young ones out to salt water as promptly as they can; but if nesting is delayed it appears that molt is also delayed—until fall or later. Witherby (1940:123) says concerning this matter: "dates of assumption of summer and winter plumage vary greatly; traces of summer plumage may still be retained in January, and in March or April all stages from full winter to three-quarters summer plumage may be seen together." In a series of 12 adults collected August 3 to September 17, 1897, by the Mc Ilhenny Expedition in the vicinity of Point Barrow, Alaska, 11 showed "no molt whatever"; one female, collected September 17, had completed the molt, though the primaries still retained "portions of the sheaths" (Stone, 1900:6).

Gavia arctica pacifica. Bent (1919:69) states that the postnuptial molt of the Pacific Loon is complete, that the prenuptial molt "involves practically all the contour feathers"; whereas Witherby (Witherby *et al.*, 1940:22) describing the closely related *G. a arctica,* says that "specimens available do not show moult of remiges" in the postnuptial molt, "though this may occur," and is sure that the prenuptial molt, which takes place February to May, is complete, the primaries, primary-coverts, and secondaries being then molted simultaneously. Forbush (1925:27) flatly asserts that both molts are complete.

According to what I witnessed on Southampton Island, I should say that most Pacific Loons have no time for a flightless period in late summer. They are busy flying in with fish for their young until fall. Whether they molt near their breeding ponds I cannot say. I did not record the species in 1929 after September 27; saw no shed feathers about the breeding ponds; neither saw nor heard of a bird in flightless condition (Sutton, 1932:14). I should say that the postnuptial molt could not well have started before October 1 in most

individuals. Just where the birds were by that date is a question. Probably they were on their way south. Since the winter home of the Pacific Loon is said to be "the Pacific coast of North America from Puget Sound to Lower California" (Peters, 1931:35), one thinks of the fall migration from Southampton Island as a long flight, or series of flights from lake to lake perhaps, across western Canada; and one wonders whether that trip may not customarily be taken before the remiges are molted. It is, I believe, significant that of 49 adult specimens collected July 5 to September 20, 1897–98 by the Mc Ilhenny Expedition to Point Barrow, Alaska, only four had molted their remiges. These four were in "full winter dress" (Stone, 1900:5).

Gavia immer. Concerning the Common Loon, Bent (1919:52) says: "The adult winter plumage . . . is worn for only a short time, as in the second year bird; specimens in this plumage are very scarce in collections and it is difficult to find one that is not either molting into it or out of it; the postnuptial molt into it begins sometimes by the last of August, but sometimes not until October; and the prenuptial molt out of it may begin in November or later in the winter and may not be completed until spring. Apparently some individuals, perhaps very old birds, do not assume this winter plumage at all, for I have seen birds in fully adult breeding plumage in September, October, and November." Forbush, (1925:17, 18) uses this passage from Bent almost verbatim. Witherby (1940:115) believes that the winter plumage "is acquired by complete moult Aug. (sometimes July) to Jan. Primaries, primary-coverts and secondaries are moulted simultaneously but wing-coverts and innermost secondaries normally. Sometimes some old summer body feathers, wing-coverts and innermost secondaries are retained until next moult. . . . Another complete moult similar to that of autumn takes place Feb.–May."

These statements make it clear that an adult Common Loon is molting three-quarters of the time. For a short period, in summer (part of May, all of June, part of July) they are apt to be in complete breeding dress. The rest of the time they are in more or less mixed plumage. But when is the postnuptial molt, which begins "sometimes July," finished? May not the dropping of the remiges often be delayed until the following winter or spring?

In this connection it is probably significant that published records of flightless molting *Gavia immer* are so few. Forbush (1925:18) tells us of one he picked up at Nantucket on March 12, 1921. J. B. May (1930:412) describes several examined by him in Massachusetts April 1 to 4, 1930, and reports one "in the gray plumage" shot by Sidney Chase at Nantucket on February 21, 1892. There is apparently no record of a flightless Common Loon found in late summer or fall. Have flightless late summer *Gavia immer* been handled repeatedly but not reported because they were considered in no way unusual? Or have ornithologists continued merely to assume, without investigating the

matter thoroughly, that all loons go through a flightless stage at the nesting lake as soon as the young are abroad?

Gavia adamsii. "The seasonal molts and plumage of the adult [Yellow-billed Loon] are, evidently, practically the same as in the common loon. . . . The molt into the winter plumage is very irregular and much prolonged, and the plumage is worn for only a short time. . . . [Collett, 1894] refers to a specimen taken on September 22 in which the molt had begun, others taken in October and November in transitional stages, and one taken on October 5 in which the summer plumage was almost entirely retained. . . . The two molts are so prolonged and so irregular that they may almost be said to overlap" (Bent, 1919:62). Witherby (1940:118) says of the postnuptial molt that there are "very few moulting examples available," but that the Yellow-billed "appears to moult" as in the Common Loon, that is, completely; he seems sure that the prenuptial molt is complete.

It is evident that individuals of the species may complete a late summer postnuptial molt on or near the breeding grounds since an adult bird was collected by the Mc Ilhenny Expedition at Point Barrow, Alaska, on September 29, which had "new wings . . . only half grown" (Stone, 1900:5); but it is quite believable that, had this individual lived, it would not have molted its remiges again the following spring.

Remarks

The above brief review has been presented not as proof that adult loons molt their remiges only once a year, but rather to show that further careful observations must be made before we can be sure that they molt their remiges twice a year. Of great importance is the recording of all adult loons known to be in flightless condition as a result of molt. Ornithologists who happen to live near nesting lakes of *Gavia immer* should observe the birds carefully in late summer and early fall, ascertaining whether they are actually flightless at any time, and checking on the observation by gathering molted remiges. A technique of capturing loons for examination and banding needs to be worked out.

It may be years before an adult loon, flightless because of molt, is captured and banded (or marked in some other way), and captured 6 to 8 months later, again in flightless condition because of molt. Until that feat is accomplished we may well refrain from statements that imply two *complete* molts per year in any Gaviiform species.

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MINNEAPOLIS, MINNESOTA

AUTUMN FEEDING AND FLOCKING HABITS OF THE MOURNING DOVE IN SOUTHERN MISSOURI

BY A. STARKER LEOPOLD

DURING the course of several years' hunting in south-central Missouri, some observations on the autumn habits of the Mourning Dove (*Zenaidura macroura*) have been accumulated that seem worth recording. The dove is not an abundant bird in the Ozark uplands, but from 1939 through 1942 I have taken 234 Mourning Doves during legal shooting periods, nearly all in one locality three miles southeast of West Plains, Howell County. Records of each trip have been kept in a hunting journal, and these form the basis for the following notes.

Feeding Habits

It has been pointed out by Moore and Pearson (1941), and noticed by many others, that Mourning Doves do not scratch for their food; since they are unable to cling to upright stalks and twigs, they are limited, with occasional exceptions (Bent, 1932:408), to the selection of food lying available on the surface of the ground. There are constant adjustments in the fall feeding habits of doves, apparently conditioned by the changing availability of surface foods. The following examples illustrate how the birds adapt their foraging in accordance with the limitations imposed by weak legs and feet.

In the accompanying table are enumerated the principal crop contents of the doves killed during this period. Quantitative analyses of crop content were not made, but all the most prominent foods are recorded. It will be seen that during September of 1939, and of 1940, the birds fed mostly on foxtail (*Setaria viridis*), which often grows abundantly in corn fields, and is admirably suited to the foraging needs of doves. The seeds ripen in August and almost immediately fall to the ground, where they are readily available until the fall rains have washed them into the soil. After this has occurred the doves turn their attention to other foods as they become available, including barnyard grass (*Echinochloa crusgalli*), pigweeds (*Amaranthus*, sp.), ragweed (*Ambrosia artemisiifolia*), dove weeds (*Croton* sp.), and various cultivated crops indicated in the table, all of which ripen somewhat later, but like foxtail shed their seeds onto the ground, either naturally or during processes of crop harvest. In September of these years, however, foxtail was the most important food. This plant has been elsewhere reported as a prominent dove food: Dutcher (1903) found as many as 6,400 seeds in one crop; and Knappen (1938) found foxtail to be the dominant July and August dove food in the southeast.

In 1941 and 1942, however, due perhaps to changed conditions of rainfall or temperature, there was no foxtail crop in this area, and the doves had to adjust their September feeding accordingly. Wheat, bar-

TABLE 1

PRINCIPAL CONTENTS OF THE CROPS OF 234 MOURNING DOVES KILLED IN THE VICINITY OF WEST PLAINS, HOWELL COUNTY, MISSOURI

Date	No. of birds	Principal crop contents
1939		
Sept. 10	6	Foxtail (*Setaria viridis*)
Sept. 14	8	Foxtail
Sept. 16	6	Foxtail
Oct. 7	5	Foxtail
Oct. 15	4	Mostly soybeans and cowpeas; some ragweed (*Ambrosia artemisiifolia*), smartweed (*Polygonum* sp.), pigweed (*Amaranthus* sp.), and foxtail
Oct. 31	7	Corn, cane, barnyard grass (*Echinochloa crusgalli*)
1940		
Sept. 2	5	Mostly wheat; some foxtail
Sept. 8	17	Foxtail
Sept. 10	3	Foxtail
Sept. 22	13	Dove weed (*Croton* sp.)
Sept. 26	7	Foxtail and barnyard grass
Sept. 29	2	Dove weed
Oct. 4	3	Cowpeas and corn
Oct. 17	2	Ragweed, barnyard grass and pigweeed
1941		
Sept. 6	10	Wheat, dove weed
Sept. 7	5	Wheat
Sept. 14	20	Wheat, pigweed
Sept. 28	10	Cane, barnyard grass
Oct. 3	8	Mostly cane; smartweed in two crops
Oct. 4	16	Millet (*Setaria italica*)
Oct. 5	14	Cane; a little smartweed and pigweed
1942		
Sept. 2	9	Wheat, millet, barley and dove weed; traces of corn
Sept. 5	15	Wheat, barley and millet
Sept. 12	4	Mostly millet; a little wheat
Sept. 16	11	Cane; traces of pigweed, red (?) clover
Sept. 18	24	Cane; traces of pigweed in three crops

ley, and millet (*Setaria italica*) were gleaned from the summer stubbles until the later weeds and crops ripened. Winter wheat, which ripens in June, largely meets the summer needs of doves, and is mentioned by Bent (1932) as a universally favorite food. But the limited supply of waste grain on the ground diminishes by late summer, and the doves readily turn to other foods when they can be had. In foxtail years this change is made in August, but when the foxtail fails to make a crop, it is September before other suitable foods appear in quantity.

The change to a newly available source of food may occur very quickly. On September 5, 1942, a concentration of approximately 200 doves was found in a wheat stubble, and the crops of 15 captured birds were filled largely with wheat. A week later, on September 12, practically no birds remained in this stubble, and it was September 16 before

I again found the local population, this time in a field of standing cane a half mile from the wheat field. All the birds were feeding on fragments of cane seed, which were dropped to the ground by thousands of blackbirds as they fed on the upright heads. The almost complete shift of the doves from wheat to cane, occurring apparently between September 5 and 12, was made possible in this instance by the "threshing" of the seeds by blackbirds. Cane is an important fall and winter food here, as it is in Alabama (Moore and Pearson, 1941), but is normally available to doves only after cutting.

Interestingly enough, Korean lespedeza (*L. stipulacea*), which has been widely introduced in southern Missouri during the past decade and is now a favorite quail food, is apparently not used by doves. It has not been found in any of the crops examined, even of birds taken during October when the seeds are lying abundantly on the ground. Either doves find it unpalatable (suggesting another limitation on the utilization of foods besides availability), or they have not yet learned to use it.

Flocking Habits

In August, the doves are widely distributed over the agricultural sections of Howell County, only the very favorable feeding grounds attracting concentrations of any consequence. At that time the flocks are loosely organized, behaving as Bent (1932:409) has described: "As we watch a number of doves feeding in a stubble field we soon see that there is no very strong tie binding together the members of the company—no such bond as holds together a flock of sandpipers. . . . The doves are spread out over the ground . . . feeding . . . like grazing cattle. . . . The flock when alarmed, instead of moving off as a unit, breaks up and the birds retreat individually or in pairs."

However, with the first cold rains in September some of the doves migrate, and a gradual change becomes apparent in the social relations of the remaining birds. Large concentrations form on a few of the best feeding grounds, and practically all the birds assemble at one or another of these favored points. By October 1 there are no doves in three-fourths of the late summer range, and the total population of a whole valley may congregate on one farm, or even in a single field. The flocks tend to cling together more closely. A small number of doves winter in this region, and the wintering birds are found almost entirely in concentrations of 50 or more individuals, usually on bottomland fields. Strays and small isolated flocks occur, but are unusual.

During the autumn period, when some of the doves are migrating and the remainder are forming into the typical winter concentrations, I have often observed particularly well-organized flocks of 10 to 20 birds whose members have, in my experience, always proved to be adult males. These male flocks fly in close formation, very much like sandpipers, to use Bent's comparison, and the birds are wary and hard to approach. Flushing or even shooting will not cause one of these units to

break up more than momentarily. On October 15, 1939, four birds were killed out of such a flock, and gonad examination proved all to be adult males, the testes averaging over 6 mm. in length, which is twice the size of testes in young birds. On October 3, 1941, two birds were shot from a similar flock of 12, and these also were adult males. This flock was seen two days later with 10 members, which would suggest some degree of stability in its make-up. The earliest date on which I have observed a male flock was September 16 (1942), and one of these birds also proved to be an adult. Therefore, in addition to increasing gregariousness among the doves as fall progresses, there seems to be a partial segregation of adult males into small, closely united flocks. All adult males are not found in such flocks, for even in mid-October many have been killed along with females and young.

Summary

The autumn feeding and flocking habits of Mourning Doves were studied in south-central Missouri from 1939 through 1942.

Mourning Doves, being unable to scratch or to cling to vertical stalks, select their food from seeds available on the surface of the ground. The periodic adjustments in their fall feeding habits are apparently conditioned by changing availability of surface foods.

Wheat fulfills the Mourning Dove's needs until the stubbles become nearly exhausted. The birds then change to foxtail if a crop has been produced; if not, they make shift on the stubbles until the later weeds and crops ripen.

Mourning Doves apparently reject Korean lespedeza, although quail prefer it.

Part of the local Mourning Doves migrate, and an increasing degree of gregariousness is evident among the remaining birds. Winter concentrations begin to form on the best feeding grounds in September.

There is a tendency toward sexual segregation among the wintering doves, some of the adult males forming into separate flocks.

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NESTING HABITS OF THE COMMON REDPOLL [1]

BY LAWRENCE I. GRINNELL

IN June and July, 1940, I visited Churchill, Manitoba, with Ralph S. Palmer, to study and photograph nesting birds. "Churchill stands at the junction of two life zones. It is precisely at the limit of tree growth, where the spruce forest dies out on the arctic tundra and both types of biological association are in contact. The country south of the townsite is bare, mossy tundra. . . . Fronds of juniper, crowberry, and lowly willow . . . compose the principal shrubby elements of the flora. Dwarf spruces . . . stand widely scattered or grouped. . . . Inland, the trees increase in number and in size, especially on warm, well drained declivities and along the river, where the bush is more or less continuous" (Taverner and Sutton 1934:8). Between June 2 and July 22, I made a detailed study of the nesting habits of the Common

Figure 1. Observation and photographic blind on platform placed near Redpoll nest. Churchill, Manitoba.

Redpoll (*Acanthis l. linaria*). The study was concentrated mainly within a mile radius of camp (two small cabins situated two miles southeast of Churchill), but several trips in search of Redpolls were made further afield, the whole study area extending from a point near

[1] The writer makes grateful acknowledgment to Ralph S. Palmer for the accompanying photographs and for help in collecting the data; also to Arthur A. Allen for invaluable advice and guidance.

the grain elevator in Churchill five miles eastward to the Gravel Pit, the highest elevation (about 100 feet) in the neighborhood. We made detailed observations, mostly from blinds, on three female Redpolls with eggs or nestlings, on 17 days, for a total of 46 hours, including all hours of the day from 3 A.M. to midnight: one nest between June 10 and 17, a second between July 10 and 20, and a third between July 17 and 21.

Pre-nesting Redpolls

From June 2, when we first recorded Redpolls, to June 10, we saw Redpolls daily but not abundantly: several solitary birds, a few pairs, an occasional flock of seven or less. In town they were usually perched on the top branches of the still bare dwarf willows (3 to 6 feet in height), or feeding on the ground near houses. Out near camp, during this period, Redpolls were more numerous among the thin lines or small clumps of dwarf Black Spruces than among the willows fringing the ponds of the open tundra. When perching they generally occupied a conspicuous position, 6 to 10 feet up, on a spruce top or on the tip of a prominent branch. A favorite feeding place was on the ground, just below the ridge of Churchill's water pipe-line, on its lee (south) side, where they fed on dry grass seeds. They were often in more or less close association with Tree, White-crowned, Gambel's and Savannah Sparrows, and Horned Larks. We recorded fewer Hoary Redpolls (*Acanthis hornemanni exilipes*) than Common Redpolls (about one Hoary to every 25 Common). In 1931, Taverner and Sutton (1934:73) found the two forms about equally abundant at Churchill; in 1930 the Hoary occurred in "somewhat smaller numbers" than the Common.

Nests

We made intensive efforts to find Redpoll nests, and it was surprising in view of the relative abundance of Redpolls that we found only nine of the season's nests. (We found 13 Redpoll nests from previous seasons.) Taverner and Sutton (1934:74) reported "roving bands" of Common Redpolls, which were probably "non-breeding individuals and birds on incubation relief." The nine nests contained a total of 33 eggs. Three nests were deserted before the eggs hatched or before the young were fledged. The nests with parent birds still present were all Common Redpoll nests. Of the total 33 eggs discovered, 24 (72 per cent) hatched; 13 of these 24 nestlings (39 per cent of the total number of eggs) survived up to nest-leaving time. This survival percentage corresponds to the 40 per cent obtained by Kendeigh (1942) near Cleveland, Ohio, for large numbers of nests of two other small Fringillids, the Song and Chipping Sparrows.

The 22 nests (both new and old) were placed 3 to 7 feet above the ground, in either dwarf trees or shrubbery on the open tundra. Five of the nine 1940 nests were in trees or shrubbery at the edges of lakes or ponds. The kind of nest tree was noted for 21 nests: 12 were built in dwarf spruces, 5 in dwarf willows, 3 in dwarf birches, one in a dwarf larch. The exact positions of 14 nests were noted: 9 saddled on more or less horizontal branches, 5 built in crotches. Using four categories, excellent, good, fair, and poor, the concealment of five (out of 19 nests for which degree of concealment was noted) was excellent. These were

Figure 2. Redpoll nest, saddled on bough, showing willow down used in the bulk of the nest structure.

all placed in dwarf spruces, most of them saddling a horizontal bough, shaded and concealed by another horizontal bough directly above. The concealment of one was good, of eight, fair, of five, poor. The poorly concealed nests were almost all built during June in deciduous bushes, such as dwarf willows or birches, before the leaves had matured. We found no nests in the dense bush, and none on the ground, though Jourdain reported (Witherby *et al.*, 1938:66) that exceptionally Redpolls nest in grass tussocks.

The shortest distance between any two active nests was about a hundred yards, though one active nest was placed in a dwarf spruce within a foot and a half of an old nest. Taverner and Sutton (1934:73)

found Hoary and Common Redpolls nesting within a stone's throw of each other.

In all nine of the 1940 nests, the bulk material was chiefly dried grasses, though in one nest, small twigs had also been used. Brown or white Willow Ptarmigan (*Lagopus lagopus albus*) feathers were used in the lining of eight nests, plant-down in five, hair in one, and lemming fur in one. The measurements of seven of the 1940 Redpoll nests are given in the accompanying table.

MEASUREMENTS OF SEVEN REDPOLL NESTS

	Range	Average
Diameter		
Top interior	4½ – 6 cm.	5.1 cm.
Top exterior	8 – 10 cm.	8.7 cm.
Depth		
Inside	3 – 4 cm.	3.2 cm.
Outside	5 – 8 cm.	6.1 cm.
Weight	10.8 – 26.7 gm.	17.8 gm.

EGG-LAYING, INCUBATION, AND BROODING PERIODS

In Alaska, Dice (1918:130) found the egg-laying interval to be one day; I found it to vary from one to two days, though one day was more usual. I was able to obtain accurate data on the incubation periods of only two sets: one, a set of five, hatched in 10 days (July 2 to 12); the other, a set of three, hatched in 10 or 11 days (July 10 to July 20 or 21). Jourdain (Witherby *et al.*, 1938:66) also found the incubation period to be 10 or 11 days. I determined the length of the brooding period at one nest: 11 or 12 days, July 11 to 22. Incubation and brooding were performed by the female; Dice (1918:130) states that "apparently the male has no function in the home life of the Redpoll other than to fertilize the eggs" (though I found, as reported below, that the male sometimes fed the nestlings).

NESTLINGS

The activity of the adult female sometimes extended from about 3 A.M. to 10:30 P.M. Tables 1 and 2 give the average attentive periods (time at the nest) and inattentive periods (time away from the nest) and average feeding intervals for the three nests and for different times of day. The attentive periods of the female at the nest ranged from a minimum of less than a minute to a maximum of one hour, 24 minutes (an average of 22.8 minutes); periods away from the nest ranged from a minimum of less than a minute to a maximum of one hour, 16 minutes (an average of 20.9 minutes).

TABLE 1

ATTENTIVENESS OF FEMALE COMMON REDPOLLS, CHURCHILL, MANITOBA, 1940

	No. of Periods at Nest*	Total Time at Nest	Av. Length of Period at Nest	No. of Periods off Nest*	Total Time off Nest	Av. Length of Period off Nest
Nest 1 (June 10–17)	25½	5 *hrs.* 50 *min.*	13.7 *min.*	26	4 *hrs.* 25 *min.*	10.2 *min.*
Nest 2 (July 10–20)	15½	11 37	44.9	18	7 33	25.2
Nest 3 (July 17–21)	16½	4 29	16.3	15½	8 43	33.7
All Nests	57½	21 *hrs.* 56 *min.*	22.8 *min.*	59½	20 *hrs.* 41 *min.*	20.9 *min.*

* Including fractional periods at beginning and end of observation time, which are counted as half-intervals.

TABLE 2

AVERAGE FEEDING INTERVALS FOR COMMON REDPOLL NESTLINGS, CHURCHILL, MANITOBA, 1940

Intervals by Nest	
Nest 1 June 10–17, nestlings aged 0 to 8 days	17 *min.*
Nest 2, July 10–20, nestlings aged 0 to 10 days	36
Nest 3, July 17–21, nestlings aged 6? to 11? days	20
Average for all nests	24 *min.*

Intervals by Three-hour Periods			
3–6 A.M.	8 *min.*	12–3 P.M.	19 *min.*
6–9	28	3–6	20
9–12	29		
Morning average	21⅔ *min.*	Afternoon average	19½ *min.*

Between 3 and 6 A.M., the female was busily engaged in search of food for the young, and was usually at the nest only momentarily, for feeding and nest cleaning. The feeding intervals (8 minutes) from 3 to 6 A.M. were very short as compared with other times of day. The female stayed very close at the nest between 6 A.M. and noon, feeding the young on the average every 28 minutes. Between noon and 3 P.M., the average period away from the nest was appreciably longer than the average period at the nest: 29 minutes as compared with 17. The average feeding interval during these hours was 19 minutes. The average attentive period at the nest from 3 to 9 P.M. was 18 minutes, close to the total average attentive period (21 minutes); but from 9 P.M. to midnight, the maximum average attentive period was reached: 80 minutes. It is to be assumed that the female remained continuously at the nest from midnight to 3 A.M., though the nests were not under observation during those hours.

Nest 1 was observed from June 10, when it contained one egg and 3 young from less than a day- to a day-old, to June 17. The female spent 57 per cent of the total hours she was observed (10 hours, 15 minutes) at the nest. Nest 2 was observed from July 10, when it contained 5 eggs (two of which hatched on the two following days) to July 20. The female spent 60 per cent of the total hours she was observed (19 hours, 10 minutes) at the nest, though she was seen to do no actual brooding on either July 18 (observed 1:30 to 3:30 P.M.) or July 19 (observed 1:55 to 3:55 P.M.).

Figure 3. Female Redpoll preening.

On July 20, she was absent from the nest during the entire 70 minutes of observation (1:20 to 2:30 P.M.). Nest 3 was observed from July 17, when it contained 5 young about 6 days old, to July 21, when the young were fledged. The female at this nest spent only 34 per cent of the hours she was observed (13 hours, 12 minutes) at the nest. The average feeding interval at this nest was 20 minutes, as compared with 36 minutes for Nest 2 and 17 minutes for Nest 1.

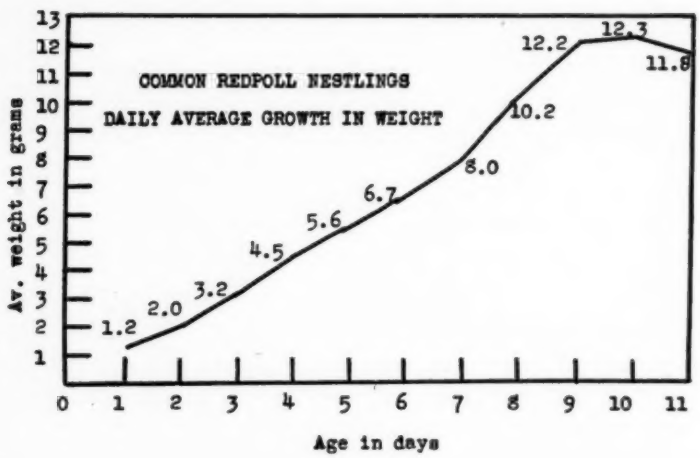
Dividing nestling period into three stages: early (age one to four days) middle (5 to 7 days), and late (8 to 10 days), the average interval between feedings was found to be 38, 23, and 19 minutes, respectively. Nestlings were fed sometimes by regurgitation, as in the closely related Pine Siskin (Dales and Bennett, 1929:76),

Figure 4. Female Redpoll cleaning nest.

Figure 5. Redpoll nestling, aged 11 days, just before first flight.

sometimes directly. Feeding was usually performed by the female, but occasionally, and contrary to the findings of Dice (1918:130) in Alaska, the nestlings were fed by the male. Frequently the male fed the female at the nest. The female, before accepting the food from the male, opened and shut her bill rapidly several times, and while taking the food, she vibrated her wings continuously; Gross (1938:255) mentions this behavior as characteristic of the Eastern Goldfinch also. After accepting the food, the female regurgitated and fed the young. In the case of a rosy-breasted male and its mate, one parent would come alone to the nest, feed the brood of five, then fly off; the other parent would come almost immediately afterward and also feed the brood.

Nests were frequently cleaned by parent birds, usually immediately after feeding the young; the parent sometimes swallowed the excreta, sometimes carried them away.



The chart shows the daily average growth in weight of the nestlings. The figures given for ages one to seven days are the average weights of four to six nestlings; weights for ages 8 to 11 days are weights of single individuals. By far the greatest percentage gain in weight occurred on the second, third, and fourth days (increases of 66, 60, and 40 per cent respectively); no gain in weight was recorded on the tenth and eleventh days.

Most female Redpolls found on nests were not very shy. They generally allowed an approach to within three or four feet (sometimes to within two feet) before flushing. When flushed, they usually flew away at once to a considerable distance. Sometimes, however, if an intruder was standing near the nest when a female returned with food, she would perch in a conspicuous spruce top and utter the nasal, questioning *tu-wee* note.

Summary

The nesting habits of the Common Redpoll (*Acanthis l. linaria*) were studied at Churchill, Manitoba, from June 2 to July 22, 1940.

Common Redpolls were relatively abundant. Nine of the season's nests were found, containing a total of 33 eggs. Seventy-two per cent of the eggs hatched; 39 per cent of the eggs resulted in fledglings.

Placement and structure of the nests are described.

The egg-laying interval varied from one to two days, though one day was the more usual. The incubation period was 10 to 11 days; the nestling period, 11 to 12 days. Incubation and brooding were performed by the female.

The active day sometimes extended from 3 A.M. to 10:30 P.M. The attentive and inattentive periods ranged from less than a minute to over one hour, averaging respectively 22.8 minutes and 20.9 minutes.

The maximum activity (feeding and nest cleaning) occurred between 3 and 6 A.M.; the maximum brooding (except from midnight to 3 A.M., when the nests were not observed) between 6 A.M. and noon, and between 9 P.M. and midnight.

Nestlings were fed usually by the female, sometimes by regurgitation, sometimes directly. They were fed occasionally by the male.

According to the stage of nestling development, average intervals between feedings were: 38 minutes (age one to four days); 23 minutes (age 5 to 7 days); and 19 minutes (age 8 to 10 days).

The nests were frequently cleaned, usually immediately after the young were fed.

Daily increase in weight of nestlings is recorded.

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BIRD WEIGHTS AS AN AID IN TAXONOMY [1]

BY DEAN AMADON

IN recent years several ornithologists have pointed out that bird weights are a valuable aid in many problems. Among general papers on this subject may be mentioned those by Mrs. Nice (1937, Chap. 3; and 1938); Baldwin and Kendeigh (1938); and Zedlitz (1926). All of these, as well as most other writers that have dealt with this subject, have been interested primarily in physiological problems, such as daily, monthly, and seasonal weight rhythms; weight changes during growth; and weight as related to various aspects of metabolism. Referring to such studies, Baldwin and Kendeigh (1938: 458) write: "A surprisingly large number of records of the weight of birds is required before reliable interpretations can be made." Unfortunately such statements have led to a general belief that in taxonomic work, where it would indeed be unusual to have a large series of weights available for each of the forms included in any given study, weights are too variable to be useful. A few taxonomists have published weights of birds, but usually only as an incidental part of their studies. The present paper summarizes and compares the various methods in common use for measuring general size,[2] and attempts to evaluate weight as an index of general size, and as a standard for use in comparing the relative dimensions of parts, organs, and appendages. The importance in taxonomy of such an index and standard may be summarized as follows:

1. *For direct comparison of variations in general size.* A kind of variation in birds very frequently used by taxonomists to distinguish geographical forms is a difference in general size (measured in various ways). A number of subspecies are based solely on this difference, and a still larger number are based on this difference plus other distinctions such as color. Of 27 subspecies of non-passerine birds which I have discussed in recent papers, 6 are based solely upon differences in general size (as reflected in measurements of appendages); 8 upon size and color; 11 upon color alone; and 2 upon differences in proportions. Subspecies of passerine birds are less often based on size variation, but this may be due to the greater difficulty in detecting such variation in small birds. Very frequently a species shows geographical size variation even though it is too slight, too gradual (altitudinal or latitudinal clines—"Bergmann's Rule"), or too irregular in distribution to justify the naming of subspecies. Mayr (1942:37) lists several instances of such variation.

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[1] I am greatly indebted to Ernst Mayr for his careful revisions of the manuscript.

[2] Alternative but less commonly employed terms are "total size" and "basic size".

2. *As a standard of comparison for measurements of parts and appendages.* The usual "taxonomic" measurements of birds—lengths of wing, tail, culmen and tarsus—are all taken from appendages. Observed variation in such dimensions may indicate variation in general size, independent variation in the appendages themselves, or a combination of the two. For example, two subspecies, A and B, might have the following measurements:

	Tail	Wing	Tail/Wing Ratio
A	50	75	2/3
B	50	100	1/2

If A and B are the same in general size, the variation in wing length and in tail/wing ratios is entirely due to B's having a longer wing. Knowing this, a biological explanation may be sought; perhaps B is more migratory or lives at higher altitudes. But if B, in general size, is larger than A by one-third, then wing length is correlated with general size, and an explanation for the variation in relative tail length may be sought. It thus becomes apparent that we usually cannot fully evaluate the biological significance of geographical variation in measurements of appendages without first relating these measurements to general size.

Linear Indices of General Size

The following linear indices of general size have been used or proposed by taxonomists working with birds:

1. *Total length.* This would be a very useful index of general size except that in birds it cannot usually be taken with reasonable accuracy, because: (a) birds' necks are relatively long and curved, and the longitudinal axis of the head meets that of the neck at an angle. The success with which this curvature is eliminated in measuring total length is affected, both by the technique of the observer and by the condition of the specimen, to such an extent as to make this measurement extremely variable; (b) as usually defined, total length includes tail length, and the tail often varies in size independently of other measurements; (c) the length of the neck and head (especially the bill portion) not infrequently varies independently of other measurements, very noticeably in such long-billed genera as *Hemignathus* of the Drepaniidae. A "body length," obtained by subtracting tail length from total length (and in long-billed genera, by subtracting also the bill length) would provide a more reliable index than total length.

When taken from museum skins, total length is even more subject to error, since such specimens are little more than tubes of skin whose length varies with the amount of stuffing put in and the amount of stretching which occurs in skinning. However, when the size differences to be measured are comparatively large, total length taken from

selected skins may prove useful. Chapman (1940:422, 426) used it with worthwhile results in his study of *Zonotrichia,* by "selecting when possible, series prepared by the same collector," and even concluded that total length when taken from such selected skins is more reliable than when taken, by various collectors, from birds in the flesh.

2. *Body length.* To provide a standard measurement that can be taken more accurately than total length, Chapin (1929:8) proposed 'length of body', defined as: "the distance in a straight line from the anterior surface of the shoulder to the vent, or, if the bird is already skinned, to the tip of the small bone (pubis) which extends down in the belly wall close to the vent." I know of only one collector who has recorded this measurement for any considerable number of specimens, and apparently no one has used it in a published study. Though it may well prove to be useful in restricted problems, 'length of body' is not a generally acceptable index of general size. The feathers interfere with the taking of this measurement, especially in birds with long, dense plumage. It cannot be taken from skins, and would be rather difficult to take from live birds. Collectors would probably prefer to take it from the skinned bodies of birds, but then comparison of measurements taken from skinned birds with those taken from unskinned birds would introduce a further element of error. Finally, there are many birds so large that this measurement could not be taken with any dividers of a size usually available.

3. *Measurements of appendages.* Lack of a good index of general size has obliged some ornithologists to use one appendage as a standard of comparison for another. Such a practice is in general unsatisfactory because, though one appendage is often correlated with another—for example wing and tail lengths frequently increase or decrease proportional amounts—each appendage often varies independently of other measurements. Though it cannot be assumed that in any given case the size of an appendage is correlated with general size, however defined, the usual measurements, especially wing and tail lengths, seem, more often than not, to be at least partially correlated with it. When it is stated that one subspecies is larger than another, usually only measurements of appendages are given as evidence of the difference. As a rule the taxonomist has noted that specimens of one race appear to be or are obviously larger in "general size," but has made no actual measurement of the general size. Sometimes it is evident that one appendage is more closely correlated with "general size" than another. Thus in comparing races of *Zonotrichia capensis,* Chapman (1940: 424–427) found a pronounced increase in wing length without a proportionate increase in tail length, which he found to be more or less correlated with general size (defined as total length). He was, then, able to use tail length as a rough measure of the relative increase in wing length. But obviously the use of a consistently reliable index of general size as a basis of comparison would be preferable to the

use of measurements of appendages, whose apparent correlation with general size or with each other is sometimes deceptive.

4. *Measurements of hind-limb.* Although the femur, the tibia, and the tarsus are segments of an appendage, there is evidence that their measurements are frequently correlated with "general size." Linsdale (1928:311) has shown graphically that in the Mariposa Fox Sparrow (*Passerella iliaca mariposae*), variation in length of tibia roughly parallels variation in weight. Since he found length of femur and tarsus to be closely correlated with that of tibia, their variation also would, in this subspecies, parallel variation in weight. Hence he used length of tibia as an index of general size and expressed all other measurements in terms of it (p. 357). Miller (1941:358) found inter-racial correlation of tarsus and weight in the genus *Junco*. These findings suggest that the hind-limb segments of birds sometimes follow Wolf's Rule (bones tend to increase in size in proportion to increases in the weight they support). Yet length of hind-limb is obviously affected by other factors, such as habits of the species; and related species of about the same general size, as shown by weight, differ noticeably in length of hind-limb. The tarsus is the only longer hind-limb segment that can be measured in museum skins. It is often rather difficult to measure accurately, especially in species in which the tarsus is short or feathered. Consequently, length of hind-limb segments is usually not a satisfactory index of general size.

5. *Measurements of skeleton.* Several measurements which give a reliable index of general size can be taken from the trunk skeleton of birds. Engels (1940:367 ff.) used two such measurements in his study of the thrashers (*Toxostoma*). He emphasized the difficulties and fallacies which usually attend studies of variation in the proportions of appendages when differences in general size are ignored (p. 368). But relative scarcity of bird skeletons in collections will often preclude the use of measurements taken from them in avian systematics.

Thus we see that all the usual measurements employed by bird taxonomists are linear measurements, either too variable to be reliable indicators of general size, or unobtainable in large series. When they are *apparently* correlated with general size, it is impossible to determine how close the correlation is without recourse to some direct measurement of general size. When an estimate of general size must be based on linear measurements, body length (defined as total length minus tail length, and in special cases, minus bill length) is usually the most reliable, unless series of skeletons of the forms to be compared are available.

Weight as an Index of General Size

Precision of weight as an index. Since birds are three-dimensional objects, mass or volume as an index of general size would seem more logical than linear measurements. In such irregularly shaped, feather-

clad objects, volume cannot be directly measured, but weight is easily recorded. It is an index of the mass of a bird and an indirect index of its volume, since closely related birds, such as are usually compared in taxonomic studies, may be assumed to have the same specific gravities. But even in the comparison of distantly related groups, weight is the best available index of general size. In comparing diverse avian types as, for example, herons with quail or songbirds, or with members of other classes, to use a linear dimension would obviously not yield valid results. But the comparative size of organs such as the brain, heart, or pituitary, can be determined by using ratios derived from the weight of the organ as compared with the total weight of the bird.

Differences in general size of solids will always be reflected more accurately by an index such as weight, which is proportional to the mass or volume of the object, than by any single linear measurement (as a simple example: in two cubes with edges respectively 2 and 3 units, the difference in volume is 19 times as great as the difference in edges). Table 1, which gives the absolute and relative differences in wing length, body length, and weight for subspecies of *Nycticorax caledonicus, Chen hyperborea* and *Pinicola enucleator,* for species of *Cacomantis,* and for male and female of *Accipiter fasciatus vigilax,* shows that the same is true for weights of birds as compared with their linear

TABLE 1

COMPARISONS OF ABSOLUTE AND RELATIVE DIFFERENCES IN WING LENGTH, BODY LENGTH, AND WEIGHT

	Wing Length (mm.)	*Body Length* (mm.)	*Weight* (gm.)
Nycticorax	Diff: 7.6 %		Diff: 17.9%
caledonicus caledonicus	2♂ 291,304 (298)		1♂: 884 (884)
caledonicus mandibularis	10♂: 267–290 (277)		3♂: 700–800 (750)
Chen	Diff: 4.7%	Diff: 8.9%	Diff: 49.5%
hyperborea atlantica	20♂: 430–485 (450)	13♂: (675)	13♂: 3175–4735 (3626)
hyperborea hyperborea	45♂: 395–460 (430)	12♂: (620)	17♂: 1815–2835 (2425)
Accipiter	Diff: 13.9%	Diff: 15.5%	Diff: 77.3%
fasciatus vigilax	5♀: 273–287 (278)	5♀: (231)	5♀: 459–502 (477)
fasciatus vigilax	10♂: 237–253 (244)	8♂: (200)	10♂: 240–309 (269)
Cacomantis	Diff: 16.4%	Diff: 10.6%	Diff: 26.5%
p. pyrrophanus	9♂: 139–145 (142)	7♂: (115)	7♂: 43.5–55.8 (48.2)
variolosus addendus	17♂: 116–126 (122)	12♂: (104)	8♂: 34.0–42.0 (38.1)
Pinicola	Diff: 9.9%		Diff: 35.4%
enucleator leucura	♂*: 116–128 (?)		5♂: 70–83 (?)
enucleator eschatosus	37♂: 106–115 (111)		9♂: 52–61 (?)

Percentages are amounts by which the larger member of each pair exceeds the smaller in each measurement. (Since the mean was not given for some of the measurements of *Pinicola,* the percentages for this species were calculated from the averages.) Figures in parentheses are the means of the measurements.

* Number of specimens not stated.

measurements. The measurements given in the table are from the following sources: *Nycticorax* (Amadon 1942*a*:4–5); *Chen* (Kennard 1927:88–89); *Accipiter* (specimens in Amer. Mus. Nat. Hist.); *Cacomantis* (specimens in Amer. Mus. Nat. Hist., in part recorded by Amadon 1942*b*:16, 20); *Pinicola* (wing lengths from Griscom 1934:7; weights from Van Tyne 1934:530). The body length was found by subtracting tail length from total length; this measurement was taken from skins in the case of *Accipiter* and *Cacomantis;* from birds in the flesh (by Kennard) in *Chen*. In the three genera for which body lengths are given, the difference between forms as compared in this measurement is, as was to be expected, markedly less than the difference in their weights. The same is true here of wing length as compared with weight, but since wing length may vary independently, subspecies may differ in mean length of wing though not (or to a less significant extent) in weight. When wing length is correlated with general size (however defined), forms will often be more sharply differentiated by weight, despite its somewhat greater variability (see below) than by wing length. The two races of *Pinicola* compared in the table seem to be an example of this; Van Tyne (1934:530) has commented on the marked difference in the weights of these two races.

Since differences in general size seem to be reflected more accurately and sensitively by weight than by linear dimensions, it should be possible by a comparison of weights to detect differences in general size which are too slight to produce a measurable difference in linear dimensions. Data to test this probability are scarce, but Mayr (1931:668–669) has published weights and linear measurements of *Melanocharis* (Dicaeidae) which are suggestive. In *Melanocharis versterii maculiceps,* females are significantly larger than males in both wing length and weight; in *Melanocharis longicauda captata,* the wing lengths of the sexes do not differ appreciably, but the females are significantly heavier. The measurements of the two forms are shown in the accompanying table. To determine whether the differences in weight in *M. l. captata* and in both weight and wing length in *M. v. maculiceps* are statistically significant in view of the rather small size of the samples involved, the "*t* test" was used (Simpson and Roe 1939:207 ff.). In all three cases this test indicated that the observed differences are almost certainly significant (less than one chance in a hundred that they are not, in each case). The slight difference in the wing lengths of males and females of *M. l. captata* is, of course, not significant.

	M. v. maculiceps		*M. l. captata*	
Wing (mm.):	6 ♂ 59.0-64.0 (61.8)	5 ♀ 66.0-71 (69.0)	7 ♂ 64-67 (65.9)	10 ♀ 64-67 (65.5)
Weight (gm.):	5 ♂ 12.5-15.5 (14.0)	5 ♀ 16.5-20 (18.5)	6 ♂ 13-15 (13.9)	6 ♀ 14-16 (15.4)

Blanchard (1941:10–11), in her study of *Zonotrichia leucophrys,* found no significant difference in the lengths of wing, tail, or other

appendages in the two races *pugetensis* and *nuttalli*. Yet she found *nuttalli* to be significantly heavier; for males the difference was 2.59 grams or about 10 per cent of the total weight. Blanchard interpreted this to mean that the lengths of the appendages are not correlated with general size in these subspecies, but it seems equally possible that even if such correlation exists, the difference in general size is too slight to be detected in the appendicular measurements.

An example of the opposite type of variation in which two subspecies differ in the lengths of appendages but not in weight was published by Grinnell (1926:406–408). In comparing two races, *Sitta carolinensis aculeata* and *S. c. alexandrae*, of the White-breasted Nuthatch, he found that although *S. c. alexandrae* weighs no more than *S. c. aculeata*, all of its appendages—wing, tail, culmen, tarsus and hind toe—are, on the average, significantly longer.

Variability of weight. Although weight is in many respects the most logical and sensitive index of general size available, it is affected by several factors such as variation in the amount of fat present, and the contents of the alimentary system. Hence many have assumed that weights are too variable to be useful in taxonomic work, but the few taxonomists who have actually used weights in their studies have not found this true. Miller (1941:255) writes, "Despite the numerous factors which affect the weights of birds..., the moderate variability of this measurement, compared with that of mammals, makes it fairly reliable." For the weights of 100 males of *Junco oreganus montanus*, collected during the breeding season, he found that: "The coefficient of variability was 5.2 per cent, which is about twice that of wing length but equal to that of some of the toe and bill measurements." Linsdale (1928:312), after discussing the factors other than geographical variation which affect weights of the Fox Sparrow, concluded: "The exact amount of the effect of each of these factors has not yet been determined, but it is thought that they have little effect on the means of large series." Regarding geographical variation in weight he said (p. 315): "It is easily seen that the average body-weight of these samples is a useful characteristic, to be used along with others for making racial distinctions."

The relative variability of weights is best determined by computing the coefficient of variability *V* (Simpson and Roe, 1939:122). Results for a number of bird forms are given in Table 2.

The species represented in the table are a mere handful, and all of them are passerines. Since the variability of linear dimensions seems to be much the same for all groups of birds, it is very likely that the variability of weights will also prove to be fairly constant. Some of the extraneous factors influencing weights may, however, be more marked in some groups than in others. Van Tyne has pointed out to me that seasonal fluctuation in the amount of fat present is greater in some

species and groups than in others. Y. Hagen (1942) in an extensive paper on bird weights, which became available after the present one was in press, gives considerable information on this question. Since he was working with a local collection, his discussion of weights as related to taxonomy is little more than suggestive.

TABLE 2

SAMPLE VALUES OF THE COEFFICIENT OF VARIABILITY (V) FOR BIRD WEIGHTS

Species	Number	V	Authority
Junco oreganus montanus	100 breeding ♂	5.2	1
Zonotrichia leucophrys nuttalli	17 breeding ♂	6.54	2
Zonotrichia leucophrys nuttalli	28 wintering adult ♂	8.55	2
Zonotrichia leucophrys nuttalli	19 wintering immature ♂	4.28	2
Zonotrichia leucophrys nuttalli	21 wintering immature ♀	7.25	2
Zonotrichia leucophrys pugetensis	43 wintering adult ♂	8.75	2
Passerella iliaca brevicauda	30 ♂	6.21±0.54	3
Passerella iliaca brevicauda	18 ♀	8.41±0.95	3
Passerella iliaca mariposae	38 ♂	5.60±0.45	3
Passerella iliaca canescens	16 ♂	5.33±0.64	3
Pachycephala schlegelii obscurior	13 adult ♂	5.07	4
Pachycephala soror klossi	11 adult ♂	4.16	4
Ptiloprora g. guisei	18 ♂	6.41	4

Authorities: (1) Miller, 1941:255; (2) Blanchard, 1941:120, 121; (3) Linsdale, 1928:313; (4) Mayr, 1931:665, 672 (raw data, calculation mine).

The variability of volumes or weights will, to some extent, represent the cumulative variabilities of the linear dimensions of the object, and will inevitably have a larger value than that of any one linear dimension. It is usually advisable to use the cube roots of weights rather than the weights themselves as a standard of comparison for linear measurements (see below). Extracting the cube roots has the effect of reducing the variability to a value comparable with that of linear dimensions. For example, available weights of *Pachycephala soror klossi* have a V of 4.16; for the cube roots of the same weights V is only 1.38; V for the wing lengths of the same sample is 1.55.

USES OF WEIGHTS IN ANALYZING MEASUREMENTS

The measurements usually used by the avian taxonomist are all of appendages. Since the independent variation of appendages is often masked by variation in general size, the general size factor must somehow be eliminated. The simplest method of doing this is to express the appendicular measurements in terms of (that is, as a ratio or percentage of) general size, thus transforming the general size in the forms to be compared to the common base 100. The transformed measurements may then be compared with the assurance that the differences observed are independent of general size.

When weight is used as the index of general size, as is advocated here, it is not valid to compare ratios derived from linear measurements divided by weights. As noted above, weights vary in proportion to the cube of the linear dimensions, and this distorts the value of the ratios. The distortion could be corrected either by cubing the linear measurements or by taking the cube root of the weights. Since the object is to compare linear dimensions, the first alternative is not acceptable. Furthermore, the approximation to volumes (or weights) by cubing linear dimensions has inherent difficulties, the most important one being that the error of the measurements is thereby increased (cubed). The opposite is true when cube roots are extracted. This was illustrated above for weights of *Pachycephala soror*. The cube root of weight may be considered to be of the same magnitude as a linear index of general size,[3] but more reliable and usually less variable, since it is a generalized quantity (like weight itself), which is independent of variation in body form or proportions. For example, in a comparison of the relative length of intestine in a pelican and a quail to show correlation of length of intestine with food habits, ratios derived by taking length of intestine over weight (or cube root of weight) would constitute a basis for significant comparison, whereas use of any linear measurement, such as body length, in species of such different body form, would give misleading results.

The method of calculating the ratio of any given linear measurement to cube root of weight will vary according to the completeness of the data available. The simplest method is to take the ratio of the measurement (e. g., wing length) over the cube root of weight for each specimen; the mean of the series is then taken. When working with published data, however, such detailed individual measurements and weights will rarely be available. It is then necessary to base the ratio upon available means or averages of the measurements. If the weights and linear measurements are taken from different individuals, and especially if different localities are involved, the specifications for the samples should be fully stated as well as the reasons for considering them to belong to a population homogeneous as to size. Sumner (1920), who was working with abundant, laboratory-raised material of *Peromyscus*, illustrates several satisfactory methods of dealing with statistical material, of which the most precise is that involving the use of regression coefficients.

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[3] Although Teissier (1931) used cube root of weight in a study of relative growth in the mealworm, the only use of this quantity in the analysis of linear measurements of vertebrates up to the present time, so far as I know, is that of Romer and Price (1941:7 ff.) in their monograph on the Pelycosaurs. For these fossil reptiles, no actual weights, of course, were available. An estimated relative weight factor or weight index was ingeniously obtained by assuming that the average area of the vertebral centrae in a given species, since the vertebrae supported the animal's weight, would be proportional to its weight (Wolf's rule). The cube roots of these weight indices were then taken and used as a standard of comparison for measurements of the skull, and various bones of the body and limbs, with valuable results.

After the mean ratio (linear dimension over cube root of weight) for each population included in the study has been secured by any acceptable statistical method, the ratios for the various populations may be directly compared. Comparison is facilitated if all the ratios are multiplied by the factor necessary to increase the largest to 100. The relative magnitude of the dimension in the various populations can then be read off directly as percentages.

The following examples are given to illustrate the use of cube root of weight in analyzing measurements of birds:

1. *Wing/tail proportions in the Fox Sparrow.* The Fox Sparrow is of interest because in the northeastern subspecies, which breeds from Newfoundland to Alaska, the wing is considerably longer than the tail, while the reverse is true in several races of the California and Great Basin mountains. Subspecies of the intervening areas of the west are more or less intermediate. A considerable variation in general size (as shown by weight) occurs among these races, and it has not yet been demonstrated whether the difference in tail/wing ratio is the result of increase in relative tail length or decrease in relative wing length in the southern races. To determine this, the general size factor was eliminated by expressing the measurements as ratios of

TABLE 3

COMPARISON OF ABSOLUTE AND RELATIVE WING AND TAIL LENGTHS IN EIGHT SUBSPECIES OF THE FOX SPARROW (*Passerella iliaca*)

	Wing	Tail	Weight	Wing Ratio	Tail Ratio
P. i. iliaca	88.5 mm.	71.7 mm.	40.7 gm.	97.9	77.3
P. i. altivagans	81.2	76.1	30.9	98.5	89.9
P. i. sinuosa	81.0	73.1	32.5	96.6	84.9
P. i. schistacea	80.4	80.6	28.9	99.7	97.3
P. i. fulva	80.8	82.2	30.1	98.8	97.9
P. i. brevicauda	83.4	84.3	34.4	97.6	96.1
P. i. monoensis	82.8	85.0	31.3	100.0	100.0
P. i. stephensi	83.4	85.2	34.5	97.5	97.0

The ratios were derived by taking: wing × 8.198 over cube root of weight; tail × 7.985 over cube root of weight (the numerical factor given for the numerator being the one necessary to increase the largest included ratio to 100).

cube root of weight. In Table 3, these ratios are given for eight subspecies, together with the absolute measurements. The weights are from Linsdale (1926:314) and Wetherbee (1934:60). Other measurements are from Swarth (1920:182). All data are for males. Because available weights of *P. i. iliaca* included both sexes, I have corrected them on the basis of Linsdale's statement that males of this species average 2 per cent heavier than females. Since the present objective is primarily to illustrate a method, it has not seemed necessary to repeat here the specifications of the samples upon which Table 3 is based. The weights of *P. i. iliaca* are from specimens trapped in New England (Wetherbee); the wing and tail lengths of this subspecies are from

four Alaskan specimens, but since they agree quite closely with measurements taken from eastern specimens, as published by Wetherbee and others, it seemed acceptable to use a ratio based on samples from even such widely separated localities, the geographical variation involved, if any, being negligible in comparison with the inter-racial variation to be analyzed. For a number of races Swarth gave measurements taken from several series collected at separate localities; in such cases I used the largest sample in the table.

Comparison of the relative wing and tail lengths given in Table 3 immediately reveals certain things which the absolute measurements do not. The eastern race, *P. i. iliaca*, is seen to have a longer wing only because its general size, as shown in weight, is larger; relatively, its wing is no longer than that of the other races. In fact, wing length is closely correlated with general size, as shown in weight, in all eight races. The tail of *P. i. iliaca* is much shorter, and that of *P. i. altivagans* and *P. i. sinuosa* considerably shorter, relative to weight, than the tails of the other five races. Swarth believed *P. i. iliaca* to be more closely related to *P. i. altivagans* than to *P. i. sinuosa*, and it is interesting that the relative tail length does not agree exactly with this division. The other five races were placed by Swarth in a "*schistacea* group" because of resemblances in color and in other characters, and this grouping receives additional support from the fact that relative tail length is almost the same in these five races. Though *P. i. monoensis* exceeds all the other races in relative length of both appendages, the difference, as compared with other members of the *schistacea* group, is so slight that we may assume that it is not significant. The general conclusion is that the geographical variation observed in tail/wing proportions of the Fox Sparrow is to be ascribed to variation in the relative length of tail. Clearly it is necessary to know this before attempting to find a biological explanation of the change in proportions.

2. *The cuckoos of the genus Cacomantis.* Out of eight subspecies of two closely related species of this genus, seven were found (Amadon, 1942*b*:17–20)[4] to have a wing/tail ratio of about .96, but in the eighth (*C. variolosus addendus* of the Solomon Islands) the ratio was only .88. Weights, which were available for *C. v. addendus* and for one of the other forms (*C. p. pyrrophanus* of New Caledonia), made possible an analysis of this difference in wing/tail proportions:

	Wing	Tail	Wing Ratio	Tail Ratio
C. v. addendus	121.8 mm.	138.8 mm.	92.78	100.00
C. p. pyrrophanus	142.2	148.3	100.00	98.62

The ratios were derived by taking: wing × 2.56 over cube root of weight; Tail × 2.42 over cube root of weight.

[4] This reference may be consulted for the size of samples, weights and other detailed data used here. The methods used in that study needed improvement by transforming the ratios to the base 100; it would also have been better to use mean ratios derived from linear measurements and weights taken from a series of individuals, and to exclude the specimens for which weights were not available.

It is evident that relative tail length is essentially the same in the two, and that the difference in wing/tail proportions has been produced by a change in relative wing length. Since it is *C. v. addendus* that differs from all the related forms studied, we may assume that it, and not *C. p. pyrrophanus*, has changed, but there are no life history data available to suggest whether the relative shortening of the wing in *C. v. addendus* is correlated with habits.

3. *Relative weights of Snow Geese.* In his study of the Snow Geese, Kennard (1927) stated that the Greater Snow Goose is "a much stockier and more heavily built bird" than the Lesser Snow Goose, and published weights and measurements to illustrate this difference, which he considered an important part of the evidence supporting his contention that the two are distinct species. However, Kennard failed to point out that a difference in weights greater than the difference in linear dimensions is to be expected, even when the body forms of two birds to be compared are alike. If the cube roots of the weights are used, a valid comparison designed to test Kennard's conclusion can be made. Analysis of his data for adult males shows that the Greater Snow Goose exceeds the Lesser by 10.5 per cent in wing length, 8.9 per cent in body length and 14.3 per cent in cube root of weight. The greater difference in the cube root of the weights does indicate that the Greater Snow Goose is a "stockier" bird than the Lesser, but the disparity is seen by this method to be too slight to be necessarily considered a specific character, for subspecies may differ in body proportions just as they do in other morphological characters.

In the examples given here, the significance of the difference in ratios is apparent; when necessary, the significance of such difference can be determined by various statistical tests similar to those recently elaborated by Reeve (1940) for studies of allometric variation in proportions.

Recording of Weights

The greatest difficulty in the use of weights in systematic work is the fact that they cannot be taken from study skins. Recording of weights on specimen labels should be made a routine part of museum collecting. This has long been done at the Museum of Vertebrate Zoology under the progressive leadership of the late Joseph Grinnell and at a few other institutions such as the University of Michigan Museum of Zoology. Weights should also be recorded during banding work. In order to increase the value of weights for taxonomic studies and for the still more stringent requirements of physiological studies, information recorded for each bird weighed should include locality, date, time of day, sex, status of species (migrant or resident) and (if the specimen is collected) the contents of the alimentary system, size of gonads, and amount of fat present.

In publications on the taxonomy of birds, weights should be given

whenever available, preferably in a way which will permit them to be individually correlated with measurements of appendages. Perhaps the only paper in which this has been done for large numbers of specimens is Mayr's report (1931) on the birds of the Saruwaged and Herzog Mountains of New Guinea. Weights should be recorded in grams, but when the cube root of weight is used, the relative values sought are unaffected by the unit or system of measurement employed, provided it is the same in all the forms to be compared.

Summary

A reliable measurement or index of general size is needed in avian taxonomy both as a direct measure of differences in general size and as a standard of comparison for measurements of appendages.

Linear indices of general size are usually either too variable to be reliable, or are not available in sufficiently large series to be of general use. Weight has moderate variability and reflects differences in general size more sensitively than do linear measurements.

When used as a standard of comparison for linear measurements, the cube root of weights should ordinarily be used.

The use of weights in taxonomic studies is demonstrated.

Weights of birds should be recorded whenever possible, to aid in taxonomic and other problems.

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SOME PHYSIOLOGICAL VARIATIONS IN THE BLACK-CAPPED CHICKADEE

BY EUGENE P. ODUM

IN addition to field observations already reported (Odum, 1941–42), I carried out, in 1939–40, a series of laboratory experiments on Black-capped Chickadees (*Penthestes atricapillus*) at the Huyck Preserve, Rensselaerville, New York.* Birds were "borrowed" from their natural environment for short periods of laboratory study, and returned uninjured to the field. Since the purpose was to measure the normal wild condition as nearly as possible, birds were kept captive no longer than necessary, never longer than overnight. All birds were banded with colored and numbered bands.

The Black-capped Chickadee provides an especially favorable subject for combination field and laboratory study, since it is easily trapped, is present throughout the year, and since short laboratory confinement seems not to affect its normal behavior out-of-doors or its lack of fear towards man. The measurements made so far only scratch the surface of possible physiological work with this species. The following variables were studied: wing and tail lengths, weight, body temperature, heart rate, breathing rate, and muscle tremors. The latter three variables were measured simultaneously with a special apparatus, the cardio-vibrometer, which has been described elsewhere (Odum and Kendeigh, 1940; Odum, 1941). Simple statistical analysis was made when data seemed to warrant it. Since many samples were small, special formulas for small samples were employed in determining standard errors (see Arkin and Colton, 1939).

Distinguishing of Sexes

Although colored alike, the sexes in the living Black-capped Chickadee can be easily distinguished during the nesting season by behavior and by the presence of a "brood patch" in the female. At other seasons there is apparently no consistent difference in plumage or behavior, though males appear to be slightly larger, as earlier workers have recorded. The maximum wing lengths (measured with the primaries flattened against the ruler) of 36 Black-capped Chickadees measured in this study ranged from 61 to 69 mm. The sex of 22 was determined by breeding behavior. Of these, 13 were males, and their wings measured consistently more than 64 mm.; 9 were females, and their wings measured consistently less than 65 mm. Consequently, careful wing measurement was an aid in sexing: in the 14 birds whose sex had not been determined by behavior, wing measurements of 66 mm. or more were taken as indicating males; those of 63 mm. or less, females; the sex of

* I am indebted to the officers of the Edmund Niles Huyck Preserve for the opportunity to conduct the experiments, and to S. Charles Kendeigh for critical reading of the manuscript.

birds with wing measurements between 66 and 63 mm. remained undetermined. Tail length varied from 60 to 65 mm., but because of the large overlap in measurements and variation in length due to wear, tail measurements were not an aid in sexing.

Body Weight

Weight records are summarized according to sex and season in Table 1. Average figures for the Black-capped Chickadee at Gates

TABLE 1

Black-capped Chickadee Weights in Grams

		Jan/Feb		Mar/Apr		June		Total		Standard Deviation
		No.	Av.	No.	Av.	No.	Av.	No.	Av.	
Rensselaerville, N. Y.	Male	21	12.4	7	12.7	7	11.4	35	12.2	±0.68
	Female	8	11.9	5	11.6	5	10.8	18	11.5	±0.70
	Both sexes	29	12.2	12	12.2	12	11.2	53	12.0	±0.75
	Sex difference		0.5		1.1		0.6		0.7	±0.20
Gates Mills, Ohio	Both sexes	36	11.5	42	11.1	10	10.4	88	11.2	±0.95
	Locality difference		0.7		1.1		0.7		0.8	±0.15

Mills, Ohio (Baldwin and Kendeigh, 1938), are included for comparison. In order to minimize daily fluctuations, all Rensselaerville weights were taken in the late afternoon, at or near the theoretical maximum in the daily rhythm of weight. Three things of general interest seem to be indicated by these data:

1. Males averaged heavier than females at all seasons investigated (a fact also reported by Baldwin and Kendeigh, 1938). The average difference (0.7 gms.) is statistically significant, since it is more than three times as large as the standard error (0.2 gms.). However, because of the considerable overlap and general variability, weight in this species is not a reliable means of distinguishing sex.

2. Rensselaerville chickadees weighed more than Gates Mills birds. The difference (0.8 ± 0.15 gms.) is easily significant provided we assume that the sex factor and daily rhythm factor are eliminated in the averages; and the difference is to be expected since Rensselaerville has the more northern climate. There appears to be a gradual southward decrease in size as indicated by wing measurements in the Black-capped as well as in the Carolina Chickadee, *Penthestes carolinensis* (see Todd and Sutton, 1936), and there is presumably also a north-south weight gradient, although this has not yet been demonstrated.

3. No difference was found between average winter and average spring weights. January and April records on the same individuals also failed to show any significant difference. But the difference between winter and June weights is significant (1.0 ± 0.19 gms.). Since most

June weights represent birds feeding young it is not known whether the decrease is correlated only with season or is perhaps partly the result of strenuous feeding activities. Seasonal variation in weight is well known, most passerines being heavier in winter than in summer (Nice, 1938; Baldwin and Kendeigh, 1938). In the generalized curve (based on a number of species) given by Baldwin and Kendeigh (1938), weight decreases 7 per cent from January to April and 11 per cent from January to June. Zedlitz (1926), however, has reported that certain European Paridae (*Parus* [*Penthestes*] *atricapillus borealis*, and *P. palustris*) as well as the Magpie (*Pica pica*) are exceptions to this general rule. The White-breasted Nuthatch (Baldwin and Kendeigh, 1938) and Tufted Titmouse (Nice, 1938) seem to show comparatively little seasonal variation in weight. From incomplete data on American chickadees it seems that the seasonal weight rhythm may not be so pronounced as in many other passerines, but since there is a complexity of factors affecting weight, far more data are needed before significant conclusions can be drawn. It should be emphasized that a few weight records from scattered localities are of no value in this connection; large series of weights from local populations are needed.

Heart and Breathing Rates

Methods. Because of the great variability of the heart and breathing rates in small birds it is necessary to determine some sort of stabilized rate—a standard or "basal" rate—if useful comparisons are to be made. The basal heart and breathing rates are defined as the average rates when the bird is in a post-absorptive (though not starved) condition, in darkness, away from human presence, and at a controlled (or specified) temperature. The same apparatus and general procedures as described in an earlier publication (Odum, 1941) were used to determine basal rates for the study birds. The individual to be tested was captured in the late afternoon, weighed and measured, kept in the dark for two to three hours, then placed on the sensitive perch within the temperature control chamber. By a simple technique previously described (Odum, 1941), it was easy to get the birds to remain voluntarily on the perch indefinitely, in darkness, and entirely free from outside disturbances. Figure 1 is a flashlight photograph of part of the experimental apparatus, showing a Chickadee resting on the perch crystal in the temperature chamber. The bird is sleeping in the typical pose assumed at lower air temperatures, that is, with head turned back, bill buried in scapular feathers, and feathers fluffed out (the same pose as that observed out-of-doors). The recording apparatus and earphones (in order to keep informed of the bird's general behavior) were in another room. After allowing half an hour or more for the bird to become adjusted to the conditions, records were made at about 15-minute intervals for the next several hours. Thus, all records were made between 8 P.M. and 12 P.M.,

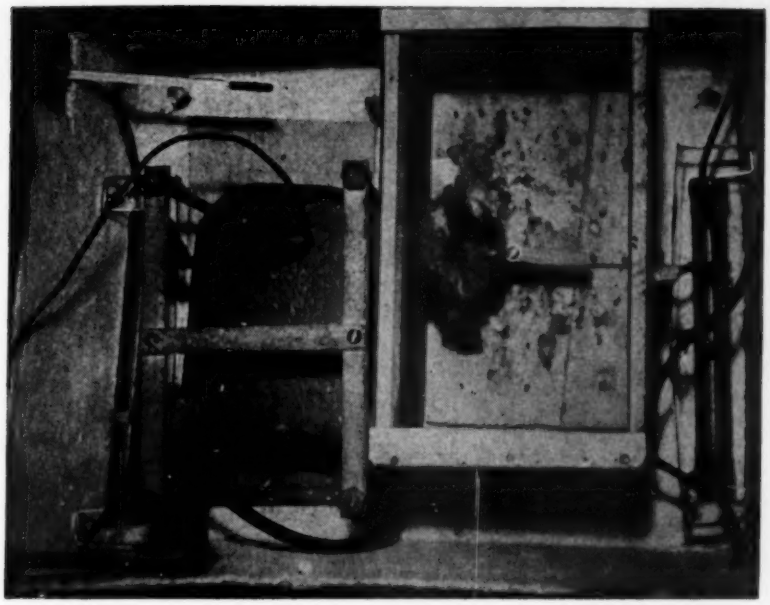

Figure 1. A flashlight photograph of a Black-capped Chickadee sleeping on the perch attached to the piezo-electric crystal (left) within the temperature chamber. The bird has its head turned back, bill buried in scapulars, and feathers greatly fluffed out.

three to seven hours after the last feeding and during the normal roosting time, the period that has previously been found most satisfactory for basal-rate determination. Birds were tested at three temperatures—90 ± 1.5°F. (32.2°C.), 70 ± 2°F. (21.1°C.), and 43 ± 2°F. (7.5°C.)—each individual usually being tested at two temperatures successively; 90° was thought to be approximately thermal neutral (temperature at which to expect the lowest rate of metabolism); 43° was selected as the lowest conveniently obtainable temperature; 70° is an intermediate point and the usual value of "room temperature." Unfortunately, the low temperature could not be duplicated during the summer.

In analyzing the graphic records and computing averages, I used the standardized procedure previously described (Odum, 1941). Since breathing rate is relatively slower than heart rate, the number of readings for breathing rate were fewer than those for heart rate, but the averages cover the same period of time. Thirty-four determinations of basal heart and breathing rates, taken from 14 individuals (of which four were measured twice), are given in Table 2. Whereas statistically, this is a small number of records, it is so far the largest series for adults of any wild species to be obtained under comparable controlled conditions.

Sex differences. Since most of the birds studied were males, no conclusion can be drawn regarding the sex factor in heart and breathing rates. Differences, if any, are probably small. Consequently, the sex factor is ignored in most of the following discussion.

Variability. It is interesting to analyze variability since it is a notable characteristic of the heart and breathing rates in small birds. In Figure 2, the variations (during a period of 36 seconds) in the heart rate of a typical individual under the controlled conditions described above are given in detail; readings taken during and between each

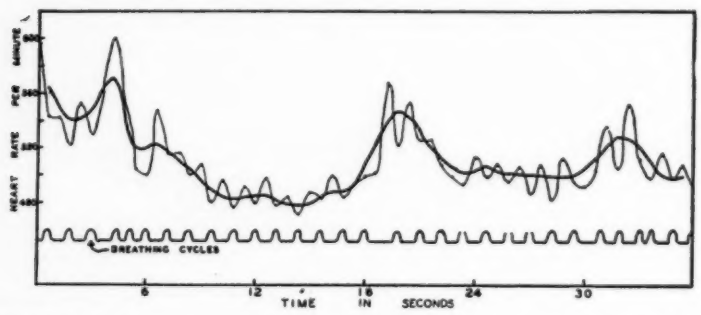

Figure 2. Inherent variations in the heart rate of a typical Black-capped Chickadee (male, June 21). Variations correlated with breathing are superimposed on large oscillatory variations (smoothed curve).

breathing cycle are plotted together with a smoothed curve (representing three "oscillatory" variations), to show the two types of inherent variation in heart rate characteristic of the study birds: 1. Variation which is correlated with the inflation and deflation cycle of the lungs, the heart rate usually decreasing slightly at the peak of the inflation part of the cycle and increasing between cycles. (In mammals, on the contrary, heart rate usually increases during inflation and slows down during deflation—Anrep, Pascual, and Rössler, 1936.) 2. "Oscillatory" fluctuations (Odum, 1941), a more pronounced, slower, and rhythmic (though not usually regular) type of variation. Oscillatory fluctuations may sometimes be related to pauses in breathing (removal of the inhibitory influence of lung inflation mentioned above), or to the action of periodic muscle tremors,[1] but frequently there is no apparent cause (though they are presumably correlated in some way with vagus periodicity). The degree of oscillatory fluctuation varies considerably with individuals; often it can be detected by ear. Inherent

[1] Tremors are defined as coordinated, semi-rhythmic partial muscle contractions or changes in muscle tone which, when pronounced, produce visible shivering. See Odum, 1942:618 or 1941:312.

TABLE 2

BASAL HEART AND BREATHING RATES OF BLACK-CAPPED CHICKADEES

Individual	Sex	Date	Temperature 90± 1.5°F.						Temperature 43± 2°F.						Temperature 70± 2°F.					
			Heart Rate			Breathing Rate			Heart Rate			Breathing Rate			Heart Rate			Breathing Rate		
			N	M	sD	N	M	sD	N	M	sD	N	M	sD	N	M	sD	N	M	sD
A–R	♂?	Jan. 19	33	518	13.6	8	108.0	12.2												
A–RY	♂♂	Jan. 22	29	411	20.9	8	80.4	5.1												
A–BY	♂♂?	Jan. 27	27	538	25.7	8	105.0	6.9												
A–Y	♂♂?	Feb. 8	45	346	18.2	11	81.3	5.6	11	614	28.3	3	73.0	...						
A–RG	♂♂	Feb. 13	35	444	17.1	9	80.0	7.7	27	550	19.8	7	69.8	3.7						
A–BI	♀	Feb. 16	33	376	31.9	11	81.3	5.6	20	582	27.9	6	62.3	3.7						
A–YR	♂♂	Mar. 2	58	445	12.9	13	107.7	15.6	25	618	38.6	5	61.6	3.9	8	548	...	2	58	...
A–BG	♂	Mar. 7	39	458	13.1	7	99.4	10.5	20	600	39.2	6	63.7	4.0						
A–GR	♂♂	Mar. 15	42	487	18.5	9	86.4	7.4	21	582	31.9	8	64.1	3.7						
A–RG	♂♂	Apr. 8	23	480	19.5	8	92.2	5.4	19	624	25.5	6	69.2	3.1						
A–BI	♀	Apr. 9	30	368	20.0	8	76.6	2.0	17	627	45.4	7	73.3	6.8						
A–RY	♂♂	Apr. 11	25	418	21.3	9	77.3	6.1	17	538	28.3	8	67.7	3.3						
A–YR	♂♂	Apr. 12	21	466	21.6	9	108.3	6.9	17	655	41.0	6	70.2	4.9						
A–YB	♀	Apr. 18							20	639	43.8	7	72.6	5.8	49	546	50.2	11	76.4	3.6
A–BR	♀	Apr. 24							15	674	36.7	5	56.5	2.0	30	548	25.3	11	51.5	3.4
B–I	♂♂	Jun. 11	30	547	25.4	9	88.4	6.6							25	539	31.2	4	56.0	...
B–2	♂♂	Jun. 20	14	524	17.3	5	65.4	1.7							14	555	23.7	6	64.7	2.6
R–GR	♂♂	Jun. 21	15	536	36.4	4	51.0	...							15	554	31.3	5	50.6	5.8

N = number readings. M = mean sD = Standard deviation.

variations are of interest for at least two reasons: first, they indicate that the heart rate is rarely uniform, and second, a series of readings should be taken in order to avoid any confusion of inherent variations with variations resulting from external factors.

TABLE 3

VARIATION IN HEART AND BREATHING RATE IN BLACK-CAPPED CHICKADEES

	Number of Individuals	Average Coefficient of Variation
A. Intra-individual Variation		
Heart rate: at 90°F.	13	4.53
at 43°F.	12	5.53
Breathing rate: at 90°F.	13	8.50
at 43°F.	11	5.91
B. Inter-individual Variation		
Heart rate: at 90°F.	13	12.50
at 43°F.	12	6.36
Breathing rate: at 90°F.	13	13.10
at 43°F.	11	7.60

In Table 3 the variation in the regular sample readings is indicated by means of coefficients of variation, which simply give a picture of the variation around the mean values. Winter and spring records are combined in order to bring out the effects of temperature and individual variation. Several points of interest are indicated as follows: 1. Heart rate varied somewhat more within the individual at 43° than at 90°, apparently because of the action of periodic tremors. At 90° no tremors were recorded, but at 43° short tremor periods often occurred, accompanied by heart rate fluctuations. The relation of tremors to heart rate and temperature regulation has been discussed elsewhere (Odum, 1941; 1942). 2. Variation in heart rate between different individuals was greater at 90°, a possible indication that 90° is not a good thermal neutral point. 3. Breathing rate, both intra- and inter-individually, was more variable at 90° than at 43°, probably because of the function of the breathing rate in heat loss as explained below. 4. Breathing rate seemed to be slightly more variable generally than heart rate, especially at high temperatures. 5. Basal rates for both heart and breathing were more constant within the individual than between individuals, indicating that both may be considered individual characteristics, as in man. Accordingly, in testing the effect of various factors it is better to use the same individuals if possible. If different individuals are used a larger series is desirable.

Effect of temperature on heart and breathing rates. Average basal rates for all individuals which were tested at the three temperatures during winter and spring are plotted in Figure 3. The principal points shown by these data seem to be: 1. As would be expected, heart

rate increased with a drop in air temperature. The increase seems to be less between 70° and 43° than between 90° and 70°. In winter the average increase in heart rate between 90° and 43° was about 10 per cent, indicating a high tolerance of low temperatures. As can be seen from Table 2, every individual showed a distinct increase in heart rate when changed from a high to a low temperature, although the degree of response varied. 2. It was surprising at first to find that the breathing rate was higher at 90° than at 70° or 43° (a seemingly opposite

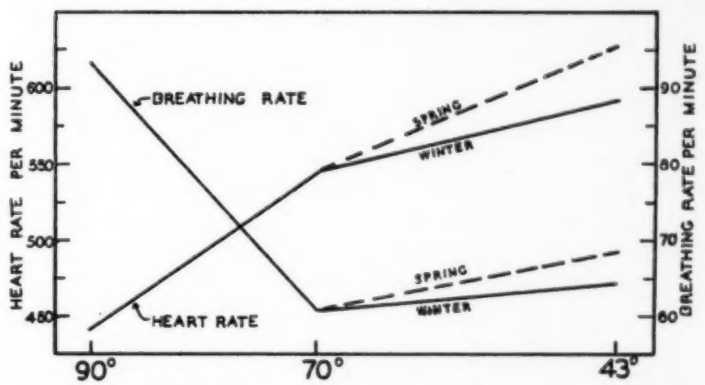

Figure 3. Average standard heart and breathing rates of Black-capped Chickadees at three air temperatures (°F.) during winter and spring. The lines connecting the averages do not necessarily follow the trends (actually unknown) between temperatures. Records at 70°F. are scanty and therefore their averages are not strictly reliable.

response from heart rate). All individuals showed this reaction (Table 2). The explanation is apparently not hard to find, however. Since the lungs and air sacs are one of the principal means of heat loss in birds, the breathing rate is an important part of the heat loss mechanism. Kendeigh (1939) has shown that an abrupt increase in water loss occurs at about 100°F. in both adult and nestling House Wrens; an abrupt increase in breathing rate also occurs in that species at the same temperature (Odum, 1941). In the English Sparrow, however, this critical point is lower—about 85° (Kendeigh, 1934:322). In Black-capped Chickadees the pronounced increase in breathing rate (presumably correlated with increase in water loss) apparently begins somewhere between 70° and 90°; 90° is, then, above the critical point. This explains both the high rate and great variability of breathing at this temperature (Table 3); some readings ran as high as 140 per minute, though at the same time the heart rate was low.

As to the internal mechanism, acceleration of breathing at high temperatures might be reflexive (occurring before a rise in body temperature, as in the dog) or central (that is, due to direct stimulation by

blood temperature rise, of hypothalamic temperature regulation centers). Actual measurement of body temperature of the study birds would have produced many unwanted disturbances, but judging from previous experiments and the low level of heart rate recorded at those temperatures, it would seem unlikely that air temperatures as low as 80° or 90°F. would in this species produce a rise in body temperature. Perhaps, therefore, acceleration of breathing at high temperatures in the Black-capped Chickadee begins reflexively, and this mechanism is augmented by the central "panting" mechanism whenever the body temperature rises. The acceleration of breathing which occurs at low temperatures, on the other hand, can probably be ascribed to increased metabolism and the well-known carbon dioxide mechanism.

The difference in behavior of birds at different temperatures was also striking. At both 43° and 70° (in summer as well as in winter) birds invariably assumed the pose shown in Figure 1, but at 90° the birds did not fluff out their feathers or turn their heads back (the means usually employed to decrease heat loss). Individuals were also more restless at 90°, moving slightly every minute or so, indicating that they were not so comfortable as at the lower temperatures.

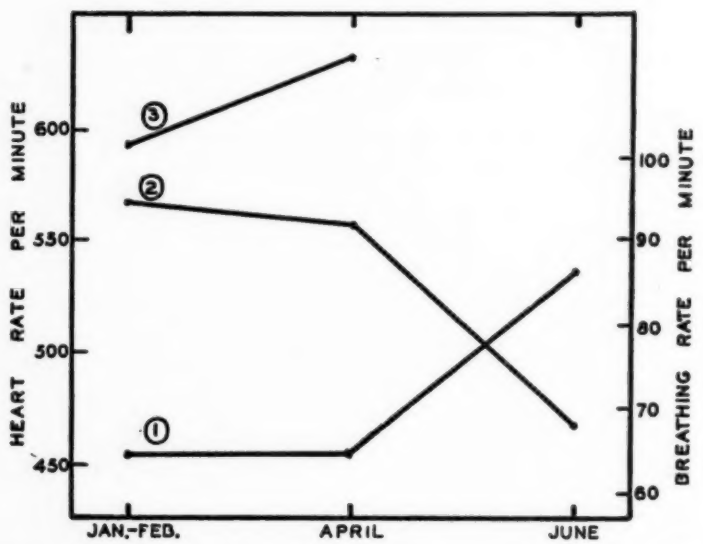

Figure 4. Basal heart and breathing rates at three seasons. (1) Heart rate at 90°F. (2) Breathing rate at 90°F. (3) Heart rate at 43°F.

Effect of season. Seasonal variations in heart and breathing rate are shown in Figures 3 and 4 and Table 2. Because of the small amount of data, only limited comparisons can be made. The basal heart rate at

90° was higher in June than in winter or spring. The average increase was 89 ± 25.1 beats per minute. The difference was also significant when males only were compared. Higher heart rate in summer as compared with the rate in winter at the same temperature is probably correlated with increased metabolism, since basal heart rate is often a good index to metabolism. Kendeigh (1934) found that in English Sparrows the rate of metabolism (as indicated by percentage weight loss) was greater in summer than in winter.

The breathing rate at 90°, on the other hand, was lower in June than in spring or winter (Figure 4). This is undoubtedly related to more rapid heat loss in summer, which may result, at least in part, from less dense plumage and lower weight (Kendeigh, 1934:335). In other words, the critical point previously mentioned (temperature at which breathing shows an abrupt increase) shifts upward in summer, and 90° air temperature no longer results in a high rate of breathing.

Examination of Figure 3 suggests that heart rate may begin to increase in the spring, especially at 43°, since readings for April were usually higher than winter averages. As already pointed out, differences are perhaps more likely to be significant if readings from the same individual are compared. Accordingly, four individuals that had been measured in winter were again tested in April under the same conditions, and the probable significance of the differences was calculated. In April, basal heart rate was significantly higher in all four individuals at 43°, but in only two at 90°. Furthermore, when all data were pooled (irrespective of individual) in order to obtain a large number of readings, the average spring increase at 90° was 16 ± 10.4 (probably not significant), whereas the increase at 43° was 52 ± 11.7 (probably significant). Thus the heart-rate/temperature curve is flatter in winter than in spring (Figure 3).

Discussion. The following generalizations seem to be justified: At intermediate air temperatures, though not at high temperatures, heart rate and breathing rate probably vary directly with each other, and inversely with the temperature. As far as present information goes, basal heart rate may be considered an index to heat production; breathing rate is also related to heat production, but at temperatures above thermal neutral it becomes a rough index to heat loss in birds (as well as in certain mammals). Consequently, the measurement of these vital rates and determination of critical points may reveal much about the bird's response to environmental conditions and its limits of tolerance. The differences between species in these respects may help to explain differences in behavior and distribution. For example, the critical temperature at which breathing shows an abrupt increase is about 100°F. in House Wrens but is appreciably lower in English Sparrows and in Chickadees in winter. Seasonal differences are also striking. In Chickadees the critical point just mentioned seems to shift upward in summer, downward in winter. Likewise, heart rate levels change with the season,

being higher in summer (when the heart rate is presumably correlated with a higher rate of metabolism) and lower in winter. As previously reported (Odum, 1941–42), survival time without food is much higher in winter than in summer. In winter, decrease in heart rate, in metabolism, and in heat loss enable the Chickadee to resist low temperatures. That is, food and shelter are by no means the only considerations in survival. Kendeigh, for example, found that the House Wren, even when food and shelter were amply provided in large cages (where the birds lived successfully through the summer), was unable to survive

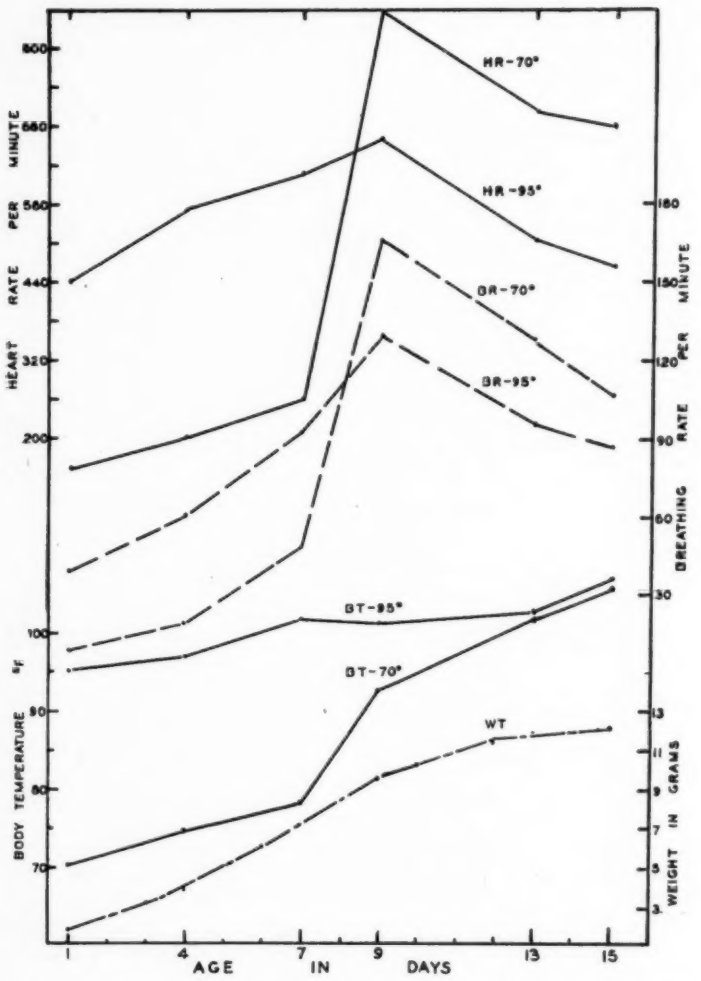

Figure 5. Heart rate (HR), breathing rate (BR), body temperature (BT), and weight (WT) of six ages of nestling Black-capped Chickadees at two air temperatures (95°F. and 70°F.).

northern Ohio winter conditions, presumably because they were unable to make the proper physiological adjustments to temperature. It should be remembered, of course, that the basal rates studied in this paper are but outward manifestations (or net results) of complex internal responses. Seasonal changes, for example, are probably ultimately related to endocrine changes.

Development of Nestlings

Data on heart rate, breathing rate, body temperature, each at two air temperatures (95°F. and 70°F.), together with the body weight of six ages of nestling Black-capped Chickadees are plotted in Figure 5 for easy comparison. Physiological development of the nestling Chickadee seems not to differ in any important respect from that of the House Wren (Kendeigh, 1938; Odum, 1941) even though the adults may differ. Consequently, only a few points need be mentioned here: 1. As in other altricial species, the Chickadee changes from a cold-blooded to a warm-blooded organism during its nest life. The transition is gradual, but changes are more rapid during the middle third of the 16- to 18-day nest life. Between seven and nine days, the two curves for body temperature (at 70°F. and 95°F.) approach each other (Figure 5, and the two curves for heart rate, as well as those for breathing rate, cross, strikingly illustrating the reversal in the response to temperature. 2. Nestlings (unlike adults in winter) have heart rate and breathing rate closely correlated at the two temperatures used in this study; 95° is for nestlings, therefore, probably below rather than above the critical point in the functioning of the heat loss mechanism. 3. The range of basal heart and breathing rates in nestlings is relatively great when different ages and temperatures are considered, illustrating the great sensitivity of nestlings to small changes in air temperature. 4. The highest heart and breathing rates were recorded at about nine days; muscle tremors were also most intense at this age. As described elsewhere (Odum, 1942), the heat production mechanism seems to develop more rapidly than the ability to control heat loss. At nine days, the feather covering of the nestlings is still poor; consequently, heat loss is poorly controlled, and this probably accounts for the high heart and breathing rates.

Summary

Wing and tail lengths, body weight, body temperature, heart rate, breathing rate, and muscle tremors (the latter three variables being measured with the cardio-vibrometer) of wild Black-capped Chickadees were studied.

Wings ("maximum measurement") varied from 61 to 69 mm., with wings of males as a rule longer; hence wing measurements were an aid in sex distinction. Tail measurements varied from 60 to 65 mm., and were not an aid in sexing.

Males averaged 0.7 ± 0.2 gms. heavier than females. Rensselaerville (New York) birds averaged 0.8 ± 0.15 gms. heavier than Gates Mills (Ohio) birds, when records from the same months were compared. The study birds weighed less in June than in winter, but weight differences between winter and spring were not significant.

There are two types of inherent, more or less rhythmic, variation in heart rate, one correlated with breathing, the other probably of variable cause.

Basal heart and breathing rates were measured at three temperatures, 43°, 70°, and 90°F. With rising temperature heart rate decreased, but at 90° breathing rate increased; this acceleration (probably reflexive) is undoubtedly related to the special role of breathing rate in the control of heat loss, 90° being above the critical temperature, especially for Black-capped Chickadees in winter.

Heart rate probably may be considered a rough index to heat production, and breathing rate a rough indicator of heat loss.

Heart rate was consistently and significantly higher in summer, and usually higher in spring, than in winter. Breathing rate, on the other hand, at 90° was lower in summer than in winter. These changes indicate an important seasonal adjustment of basic physiological rates (including the rate of metabolism), and are undoubtedly significant in the species' successful adaptation to changing seasonal conditions.

Physiological development of the nestlings was similar to that of the House Wren. Weight increase followed a sigmoid curve. Temperature regulation was established gradually, the most rapid changes taking place during the middle third of nest life. A peak in both heart rate and breathing rate was reached at about nine days of age, after which both decreased as the control over heat loss became more effective.

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GENERAL NOTES

Herring Gull attack on normal Golden-eye.—On several days prior to April 11, 1943, an American Golden-eye (*Bucephala clangula americana*) fed by diving in the breaking waves in front of our home on the east shore of Put-in-Bay Harbor, South Bass Island, Ohio. The bird was a young male in changing plumage and therefore readily distinguishable from its fellows. I saw him in flight several times, and he appeared to be normal in every respect.

On the evening of April 11 he again appeared in front of our home, feeding about 50 feet offshore at the point where the huge waves began to curl and break. He usually waited until a wave was about to break over him before he dived. While he was diving, an adult Herring Gull (*Larus argentatus smithsonianus*) came flying along the shore, swooped down and attempted to grasp the duck with its bill. The duck escaped capture with a quick dive. This was repeated several times until finally the gull succeeded in obtaining a firm hold near the base of the duck's right wing. Both birds began to struggle furiously, the duck attempting to dive, the gull to drag the duck toward shore. Occasionally both birds were almost submerged by the breaking waves. After about two minutes the duck broke free and dived, coming up some 100 feet away, and the gull again attacked. The duck escaped by diving, and swam under water for several yards. On appearing at the surface he flew away. The gull started in pursuit, and coming up with the duck, made repeated though unsuccessful attempts to knock it down into the water. The duck began to out-distance the gull, which then gave up the chase. I have seen Herring Gulls attack wounded or dying birds but never before have I seen one attack an apparently normal individual.—MILTON B. TRAUTMAN, *F. T. Stone Laboratory, Ohio State University, Put-in-Bay, Ohio.*

Vermilion Flycatcher at St. Marks, Florida.—Observations made during the past three years at the St. Marks National Wildlife Refuge, St. Marks, Florida, indicate that the Vermilion Flycatcher (*Pyrocephalus rubinus mexicanus*), is less rare—at least in northwestern Florida—than the single record from earlier years would indicate.

On December 26, 1940, while making a Christmas bird census, D. V. Gray and L. S. Givens observed a Vermilion Flycatcher, and collected it the following day. The specimen was identified by H. L. Stoddard of Thomasville, Georgia. According to A. H. Howell's "Florida Bird Life" (1932:327), the only other record of this species for Florida was a bird collected at Tallahassee on March 25, 1901, by R. W. Williams. In mid-December, 1941, and during the first week of January, 1942, a Vermilion Flycatcher was again observed on the St. Marks Refuge, by H. L. Stoddard. On December 10, 1942, Givens observed a female Vermilion Flycatcher there; and on December 24, while making a Christmas bird census, he saw an adult male and collected a female (probably the same bird seen December 10). In the same general location Givens again observed an adult male and female on January 1, 1943. These two birds were seen repeatedly at the Refuge throughout the winter of 1942–43. The last record was of a male seen by Givens, J. J. Lynch, and Clarence Cottam, not far from headquarters, on March 14, 1943.—LAWRENCE S. GIVENS, CLARENCE COTTAM, and DONALD V. GRAY, *U. S. Fish and Wildlife Service.*

A wren singing the songs of both Bewick's and the House Wren.—On April 18, 1943, at my home in the northern part of Columbus, I was surprised to hear a wren singing the songs of both the House Wren (*Troglodytes aedon*) and of the Bewick's Wren (*Thryomanes bewicki*). The bird uttered the notes of one species for a few minutes, then changed to the notes of the other. Each song seemed perfectly characteristic of the species indicated. I heard the bird sing

only one of the two principal types of Bewick's song: the one which has been whimsically transcribed as "Eat a piece of che-ee-eeze!"

After singing for several minutes from three perches in the tree tops, the bird dropped to the ground, where I obtained a fairly satisfactory view of it, although the obstructing stems of shrubbery in which it was foraging prevented critical study. In appearance, it seemed a typical Bewick's Wren, with a conspicuous, whitish superciliary line, white tips to the outer tail-feathers, and the characteristic "tail-wobbling" habits, except that the tail seemed a trifle shorter than that of the average Bewick's Wren, and the flirting of the tail was not so free. Unfortunately my attempt to collect the bird was unsuccessful.

Two possible explanations readily present themselves: (1) the bird was a hybrid, and (2) it was a Bewick's Wren with the ability to mimic the House Wren. Without the bird in the hand, the question must remain a matter of speculation.

The ranges of the two species, geographical and ecological, overlap only to a slight extent. At Columbus, the House Wren is abundant, Bewick's infrequent. It is under such conditions, namely, where one of two species in question is rare in a given locality, the other abundant, that hybridism seems to occur most frequently, since an individual of the rare species then has less opportunity of finding a mate of its own kind. The Blue-winged Warbler (*Vermivora pinus*) and the Golden-winged Warbler (*Vermivora chrysoptera*) are a case in point. I have listened critically on many occasions to songs of the Bewick's Wren and have never heard one which varied far from the usual types. They were always characteristic and never showed the faintest suggestion of mimicry.—Edward S. Thomas, *Ohio State Museum, Columbus.*

Notes on a Captive Redstart.—From June 13 to 30, 1942, I studied the growth and activities of a juvenile Redstart (*Setophaga ruticilla*) that I captured when it flew from its nest in an isolated 25-foot Norway maple (*Acer platanoides*) located about 75 feet from a wooded park in Washington, D. C. The nest was situated 15 feet above the outside traffic lane of a principal street, on a small branch that sloped steeply upward. An old Redstart nest, apparently of the previous year, occupied a similar site a few feet away in the same tree. The recent nest, when first discovered May 28, contained eggs; on June 4, it contained two eggs and one small young; and on June 13, two young, which flew from the nest when nearby leaves were touched. While I was photographing the two young on the ground, a heavy thunder storm began. One fledgling flew to a perch on a protected branch, but the other remained exposed to the weather. The parent Redstarts, which had been fluttering excitedly about attempting to lead the young to cover, went away. I took the wet young bird home and retained it for study until June 30, when I released it because of the failure of my mealworm supply.

Growth. At 10 days of age, the rectrices, whose tips were barely visible beyond their coverts, began to break out of their sheaths. The yellow patches on the tail feathers became completely exposed on the twentieth day. The remiges seemed to grow at equal rates. At 13 days of age, the yellow areas of the wings first appeared as narrow wing-bars, showing about one mm. beyond the greater primary coverts. These yellow patches were fully visible at 26 days of age, projecting 8 mm. beyond the coverts; the distal secondary was 45 mm. long at 16 days of age and measured 47 mm. on all succeeding days.

Post-juvenal Molt. At 22 days of age the slate gray juvenal plumage of the occipital and dorsal tracts was being replaced in quantity by olive-green first-winter plumage. The underwing coverts, yellow in color, also began to appear at this time; previously the underwing areas had been naked. The post-juvenal molt was thus begun before the juvenal plumage was fully acquired. According to Dwight (*Annals N. Y. Acad. Sci.*, 13, 1900:288), the post-juvenal molt of the Redstart does not include the flight feathers.

Calls. A loud, vigorous chip and a lower, but still extremely noisy, chippering food call comprised the vocal efforts heard during the study period. From about 14 days of age, the formerly indefinite chipper began to conform to the song pattern of the adult: an ascending, increasingly loud *chip-chip-chip-chip-chirp*. The bird snapped its bill occasionally, especially when being fed.

Feeding Habits. I fed the Redstart mealworms in quantity (it would accept 4 or 5 an hour) until all available sources were exhausted. Mushy egg yolk, mashed commercial turtle food (largely ant pupae and small bivalves), and canary "vitamin" seed mixture were offered as alternates.

On several occasions the Redstart squeezed itself through the bars of its cage in order to beg food from a captive juvenile Cardinal. At these times, each bird would beg food from the other, with open mouth and quivering wings, until tired.

At 16 days of age, the young Redstart keenly watched a house fly as it flew about the cage, but made no attempt to catch it. Though the Redstart occasionally picked up small fragments of food, it at first showed no interest in mealworms crawling before it. But at 25 days of age, after several vain attempts, it caught and ate one worm. It would not follow a worm, however, when the worm moved out of reach. The bird seemed able to recognize the several foods offered it, preferring mealworms, dead or alive, above all. Egg yolk was usually acceptable, but vitamin and turtle foods were consistently refused. Upon release at the edge of its home woods, it immediately picked at minute dots on nearby leaves and made a circular flight in weak pursuit of a passing gnat.

Flight. In contrast to juvenile Cardinals studied in captivity, the extremely buoyant flight of the young Redstart was amazingly expert. The Cardinals, for almost a week after leaving the nest, were able to fly only along straight, sometimes slightly climbing, routes when escaping capture. Invariably, blind collision with a wall or other barrier terminated their flights. The Redstart, however, from its first attempt, apparently selected its next perch and then landed accurately upon it. On the first day out of the nest, it was seen to look over its shoulder, squirm about to secure a good footing, and then spring into the air to land on a perch a foot behind and above it. On the second day it could climb at a 45° angle on flights of 6 to 15 feet. By the ninth day out of the nest, it could hover expertly and even when hovering, move backward a few inches in the air. (These habits became established in Cardinals only when they were several weeks older.) At this age, it would dart about, hummingbird-like, hovering at several points, in a cage one cubic foot in size.

"Crawfishing." For a period of two or three days after capture I noted a peculiar habit, best described as "crawfishing," whenever the bird was lifted from its perch and placed on a flat surface. It would extend its wings as far forward as possible, draw in its head, spread its tail, and run rapidly backwards until halted by collision or until (after moving 2 or 3 feet) it became tired. The exact reason for this reaction was not apparent, but it seemed probable that it was in some way connected with an instinct to withdraw into the nest when the feet are not in a perching position. It did not seem purely a question of balance. This reaction was not tested upon soil or a rough surface, and I saw no evidence of it when the birds were originally captured and photographed on a lawn. The habit was less apparent on the second day out of the nest, and it stopped by the fourth.

Intelligence. In addition to its apparent deliberation before flying, the superior intelligence of the Redstart was illustrated by its ability to search for an opening in its cage and to make its way out. Whereas captive Cardinals and Quails would remain perched or repeatedly and blindly attempt exits through openings obviously too small, the Redstart made no futile attempts but searched until it found a practical way of escape. Such an escape route, once discovered, was tried persistently without further searchings until it was blocked. Undoubtedly, more formal experiments would reveal similar superiority of the Redstart, over Cardinals and Quails at least, in escaping from simple mazes.—GEORGE A. PETRIDES, *American University, Washington, D. C.*

Cowbird carrying away and eating a bird's egg in the evening.—On May 28, 1943, I was looking out of a window of my house near Ann Arbor and saw a female Cowbird (*Molothrus ater*) flying toward the house from a field of tall grass and winter wheat about 40 feet away. When the bird was about 10 feet from the house, flying about a foot above the ground, a small white oval which it was carrying in its beak dropped to a small patch of hard clayey soil. It was a small white egg, similar in size and color to the egg of the Song Sparrow. The Cowbird alighted, punctured the shell with its beak, and began to sip the albumen. After a time she removed the yolk whole, swallowed it, and then finished sipping the albumen. By this time the shell had broken into two pieces, and one piece had rolled a few feet down a slight incline. The Cowbird ate the part of the shell near her, then moved down the slope and finished the other. I carefully examined the ground after she had flown away but failed to find any trace of shell. I noticed a male Cowbird within three or four feet of the female while she was puncturing the egg and eating its contents, but he flew away before she had finished eating the two pieces of shell. This incident occurred at about 5:15 P.M. E.S.T., though Hann (*Wilson Bulletin*, 53, 1941:220) has reported that Cowbirds regularly remove an egg of the host "during the forenoon," usually of the day before laying their own egg.—Ada L. Olson, *University of Michigan Museum of Zoology, Ann Arbor.*

Abnormal feather loss by Cardinals.—Some years ago George Miksch Sutton recorded (*Oologist*, 34, 1917:216) a specimen from Texas of a Cardinal (*Richmondena cardinalis*) with completely featherless head. Amelia R. Laskey tells me of two occurrences of baldness among the 1,621 Cardinals she has banded over a period of 12 years at Nashville, Tennessee. They were females, banded (1) August 20, 1936 (recorded as "almost bald"; plumage normal when taken again in December), and (2) July 10, 1939 ("head bald, except for crest"; not taken again). Milton B. Trautman has reported (*Univ. Mich. Mus. Zool. Misc. Publ. No.* 44, 1940:397) some late summer Cardinals with completely bald heads at Buckeye Lake, Ohio. He tells me further that most of these were observed between mid-August and mid-September, though he once noted an individual with pronounced feather loss by July 4.

Recently I observed an extreme case of this kind and was able to learn something of the attendant circumstances. A male Cardinal was banded December 26, 1934, by Thomas H. Weller at his home in Ann Arbor. On July 20, 1941, it appeared at my home (three-quarters of a mile to the northeast) and has since lived in the neighborhood. It feeds at my window feeding shelves, and I can observe it closely and regularly. Early in June, 1942, I noticed that it was losing feathers from the head. By late June, the head, except for two or three crest feathers, and the upper neck were bare. On July 3 the bird was a "vulture Cardinal" such as Sutton has described, with the head covered only with dark gray, wrinkled skin. I saw no other indication of parasites or disease, and the bird's behavior was normal. Its appearance, though rather repulsive, apparently did not interfere with nesting activity, for on August 7, it brought a full-grown young to the shelf and fed it. On September 1, when it reappeared, after a two week's absence, feather growth had begun again about the base of the culmen. This continued, spreading back over the head and neck, until, by September 28, the normal feathering was entirely restored. The bird stayed through the winter and spring, and this year, its tenth summer at least, it has remained perfectly normal in appearance and has not yet (August 12) begun the regular post-nuptial molt.

Thus we have a record of a Cardinal at least eight years old, losing all of the feathers from its neck and head in June, remaining bald, but living normally through the whole summer, growing a complete new set of head feathers in 28 days, and remaining fully feathered during at least the following 10½ months.—Josselyn Van Tyne, *University of Michigan Museum of Zoology, Ann Arbor.*

Gambel's Sparrow in Kentucky.—During the winter of 1942–43 we trapped 17 sparrows (*Zonotrichia leucophrys*) on Meade Avenue one-half mile south of Louisville in Jefferson County, Kentucky—12 immatures and 5 adults. Four of the adults were typical White-crowned Sparrows (*Z. l. leucophrys*) with the superciliary stripe extending only to the eye, but in the fifth, a bird banded on January 6, 1942, the stripe extended all the way to the bill, the diagnostic character of Gambel's Sparrow (*Z. l. gambeli*). At the time we banded the bird we noted that it was always alone while feeding and was the only individual of the species to visit a high feeding tray. Since the bird had returned for the second winter, it was probable that it wintered regularly in Kentucky with our usual flock of White-crowned Sparrows. We have had returns of six White-crowned Sparrows during the last two winters—which would indicate that at least some members of this flock return to the same spot in Jefferson County year after year; repeats during December, January, late March, April, and May indicate that individuals tend to remain through the winter in the same location (except possibly during February and early March, for we have found no White-crowned Sparrows then).

The Gambel's Sparrow noted above was collected on December 21, 1942, and is in the collection of the University of Louisville. As far as we have been able to ascertain, no earlier record of this western subspecies has been published for Kentucky.—HARVEY B. LOVELL, *University of Louisville, Louisville, Kentucky.*

A bald Song Sparrow.—On February 26, 1932, a male *Melospiza melodia* in normal plumage arrived at Columbus, Ohio, and I banded him ten days later. From his prompt ejection of two residents in possession (one a yearling, the other a two-year-old of a markedly non-aggressive nature), I assumed that the newly banded male had nested there before. On May 24, when his first young were five days out of the nest, his forehead, chin, cheek, lores, and part of the crown were bare of feathers. On June 9, I found his second nest, and I then noted that his head was entirely bare except for a small tuft on the crown. I did not see him again that season, but in 1933, he arrived on March 2 in perfect plumage. A few days later he was driven off by the destruction of cover on the study area.—MARGARET M. NICE, *5708 Kenwood Avenue, Chicago, Illinois.*

IMPORTANT GIFT TO THE LIBRARY

The Wilson Ornithological Club Library has just received a valuable gift from R. M. Barnes, of Lacon, Illinois, for 33 years editor of *The Oologist*. The gift includes 725 copies of natural history magazines, most of them published by amateur naturalists during the last century. Some journals published but a single number, others lasted several or even many years, but all have since become rare items. Certain of these are now of hardly more than antiquarian interest, but a number of them contain the early contributions of men who became well known ornithologists. Their early records of contemporary wildlife conditions are now carefully studied in the attempt to reconstruct a picture of the former numbers and distribution of American birds.

Mr. Barnes, realizing long ago the value of these publications, began to collect them, and in 1915 he published in *The Oologist* an extensive bibliography of such journals by Frank L. Burns, former editor of *The Wilson Bulletin*.

The Wilson Club Library already contained the beginnings of a collection of these journals, but progress was slow until Mr. Barnes added his support to our project. The Club is thus further indebted to Mr. Barnes who had already given it his steady support as a member for 35 years.

EDITORIAL

War conditions again prevent our holding an Annual Meeting. The election of officers will be carried out by mail as was done last year. We have not yet been notified of the appointment of the Nominating Committee, but that may be expected shortly, and we shall be glad to forward to that committee the suggestions and opinions of members sent in our care.

Annual Meetings have always been of vital importance to the growth of the Club. There is real danger that the Club may lose ground during the war unless our members give the Club special support in its membership campaign and in its publishing and other activities.

We are sorry to report that the pressure of his duties in the U. S. Army Air Corps has caused George Miksch Sutton to resign from his position as President of the Club. His place is taken by Vice-President S. Charles Kendeigh of Champaign, Illinois.

Ornithological News

Our Associate Editor, Frederick N. Hamerstrom, Jr., has joined the U. S. Army Air Corps and is now at Randolph Field, Texas, where he is doing research in aviation physiology.

The 1943 annual meeting of the American Ornithologists' Union has been canceled, but the Council will meet in New York, on October 20, to transact necessary business.

Following the death of Bayard Christy, founder and editor, *The Cardinal* has ceased publication. The Audubon Society of Sewickley Valley (Pennsylvania) had published the journal under Christy's distinguished editorship since January, 1923.

OBITUARY

Norman A. Wood, Emeritus Curator of Birds in the University of Michigan Museum of Zoology, died at Ann Arbor, September 7, 1943, at the age of 86. He had been a member of the University faculty for 48 years and had done extensive field work on birds and mammals in Michigan, North Dakota, Florida, and China.

William E. Saunders, dean of Ontario ornithologists, died in London, June 28, 1943, at the age of 82. A very active and skillful field naturalist, his remarkable knowledge not only of birds but also of mammals and plants was widely recognized. He was President of the Wilson Ornithological Club in 1912 and 1913.

Bayard H. Christy of Sewickley, Pennsylvania, died June 20, 1943. He will perhaps be best remembered as founder and editor (through all of its 21 years) of *The Cardinal*, for it reflected so well his unusual ability as a writer and editor, his knowledge of birds, his interest in history, his zeal and courage as a wildlife conservationist, and his high scientific standards.

James Moffitt, Curator of Birds and Mammals in the California Academy of Sciences, was killed in an airplane crash at Dutch Harbor, Alaska, on July 2, 1943, while serving with the U. S. Navy. He had published extensively on game birds, especially water fowl, and was an authority on the geese of North America.

ORNITHOLOGICAL LITERATURE

ECOLOGY AND MANAGEMENT OF THE MOURNING DOVE, *Zenaidura macroura* (LINN.), IN CASS COUNTY, IOWA. By H. Elliott McClure. Agric. Exper. Sta. Iowa State College Research Bull. No. 310, 1943:355–415.

Thirty months were spent on the study reported in this bulletin: during 1938 and 1939 visits were made every other day to all nests on the 160 acres in Lewis, Cass County, Iowa, and on 60 acres on farms and other sites near Lewis; during 1940, nests on 10 acres in Lewis and 5.5 acres of farms were visited every day. In all, "nearly 4,000 nestings" were recorded. Bands were put on 1,643 young from 4 to 9 days old; some young were raised by hand; "several" of these later bred in cages.

Of the 36 tables in the bulletin, a full 10 are devoted to the trees in which the Mourning Dove nested; but they give little information beyond the fact that except for evergreens, which were especially favored, most of the trees "were used in accordance with their abundance" (p. 373). The Doves benefited from Robins as nesting neighbors because of the latter's aggressiveness toward enemies, but suffered from over-abundance of English Sparrows, which "usurped the available nest sites," especially on the farms. The chief known causes of nesting losses were unfavorable weather, Blue Jays, fox squirrels, and cats. The percentage of eggs (we are not given the actual numbers) to produce successful young (young that reached the age of 14 days) was 54, 44, and 38, respectively, for the 3 years, averaging 45 per cent, a figure which corresponds to the success of passerines in open nests. The average number of young raised per nest was 1.82; the average percentage of nestings that succeeded was 48. The bulletin includes information on the growth of the young, on food, parasites, and migration, as well as suggestions for management—planting of trees, provision of water, control of *Passer domesticus*.

The bulletin has proved difficult to read, partly because of its condensed form and the author's failure to explain various techniques and tables, and partly because nowhere is there a tabulation of the number of all the nestings, eggs laid, hatchings, and young fledged each year for town and country, with percentages of success and failure. Tables 35 and 36 are impossible to understand without recourse to the author's paper in *The Auk* (59, 1942:64–75), in which actual figures for nestings are given for 1938 and 1939, but this essential article is not, strangely enough, cited in the bibliography of the bulletin.

It is unfortunate that the author did not thoroughly acquaint himself with the published material on the life history of his subject before starting on his project. It is certainly hard to believe that some eggs hatched in 11 days and others in 20 (p. 382); the known co-ordination between hatching of squabs and the appearance of pigeon milk in the parental crops would certainly preclude such a spread. He makes the surprising statement that "usually 24 hours elapsed between eggs, but sometimes they were laid *12 hours apart*" (p. 381, italics mine). In my article on the nesting of this species in Oklahoma, published in 1922 and 1923 (*Auk*, 39:457–474; 40:37–58), I cite Charles O. Whitman (Behavior of Pigeons, III. *Carnegie Inst. Wash. Publ.* No. 257, 1919), who stated that with the Mourning Dove the first egg is laid in the late afternoon of one day and *the second on the morning of the second day after*. This was the case with my captive bird that laid 15 eggs (*Condor*, 33, 1931:148–150). McClure's statements as to the intervals of egg laying could not have been based on wild birds since he did not visit nests twice a day. If his captive Doves laid at such amazingly short intervals, he should have marshalled his evidence and published this contradictory experience as such, not as normal behavior.

As to instances of three eggs in a nest, McClure gives the wrong interpretation (p. 391); the extra egg comes from another bird, or the nest owner lays an egg from her next clutch—six days after the second egg of the first set.

A calculation (p. 409) of the speed of migration is based on the assumption

that a bird started when 19 days old. Although the author's captive birds weaned their young at 16 days, it does not follow that wild young are cast adrift so early. I have seen well grown young, apparently about a month old, still fed by their parents, and McClure himself reports (p. 389) that the "growth of flight and tail feathers continued until the young were over a month old." It does not seem probable that young start migration before the age of 4 weeks.

When the author deals with the success of nests, he is on sure ground. But as soon as he talks about the *number of pairs* involved, at once an unknown enters. It is very difficult to estimate the number of pairs in a crowded population of this species; yet the accuracy of such estimates is of fundamental importance in the matter of the number of broods attempted and calculations of "production," both in the study area and in the county. In the bulletin, the technique used for estimating is not described. In the 1942 paper we read (p. 65): "The greatest number of nests existing in one day during the summer was taken as indicating approximately the number of nesting pairs for the area." On page 74 we are told: "Censusing by this method ... at best can only be a somewhat closer estimate than a guess." And the reader must take care not to accept the "estimates" or "guesses," presented in the tables and summaries in the bulletin, as proved facts.

McClure considers that the Mourning Dove population in Iowa trebles each year (p. 361). His technique for estimating populations (by counting active nests and using ratios derived in the 1942 paper mentioned above) is illustrated on pages 410–412 of the bulletin. He gets astonishingly high figures: if 20 active nests are found on 20 acres in June "after 5 days of mild weather," $6.6 \times 20 = 132$, the total nesting attempts (6.6, from Table 35, being the observed ratio of daily active nests in June to the season's yield); $50\% \times 132 = 66$, the successful nestings expected; $66 \times 1.82 = 120.12$, the total young production (1.82 being the average number of young raised per nest); $1.1 \times 20 = 22$ breeding pairs (1.1, from Table 36, being the supposed ratio of active pairs seen nesting in June to the total breeding stock); allowing a 10% variation, and correcting for loss (3 to 10 per cent), "the total number of birds expected by the end of the season is 133–175 from 20 acres." In other words, the original 44 birds have *trebled* at the least, *quadrupled* at the most.

In Table 22 of the bulletin, however, estimates of the population on the 220 acres gave seasonal averages of 5.4, 5.1, and 4.6 nesting attempts; these calculations credit them with 6 (132 attempts for 22 pairs). Further analysis of Table 22 shows the average number of breeding pairs to be not 290 (as given in the 1942 paper), but 340, which divided by 260 (the average number of active nests per day in the observation area), gives 1.3 instead of the 1.1 used in his illustration. This revised factor gives 26 pairs to 20 nests, so that the "total number of birds expected by the end of the season" would be only 2.7 to 3.5 times the original population, while the nesting attempts would average 5. That the area (220 acres) on which Table 22 was based is the same as the area covered in the 1942 paper, was confirmed for me by the author. As shown in Table 22, he revised his opinions as to the number of pairs involved, but republished the tables of ratios (Tables 7 and 8, 1942, become Tables 35 and 36, 1943) without revision, and moreover he uses the unrevised ratios to illustrate his method. But even with the above corrections, I still believe the author's figures for the number of nesting attempts and for population increase are too high; I believe he underestimated the number of pairs in town, as well as underestimating the percentage loss of juveniles and adults.

The overestimate of population increase not only weakens the paper and shakes the reader's confidence in the rest of the results—it plays directly into the hands of the hunters, and this in the case of a bird gravely endangered over a large part of its range. The author has done a great deal of hard and faithful labor in connection with this study, and he has obtained worthwhile data. They would have been far more valuable if he had studied the pertinent literature and acquainted

himself with the biology of the species chosen, and also if he had used more care in his calculations.—Margaret M. Nice.

THE BIOTIC PROVINCES OF NORTH AMERICA. By Lee R. Dice, University of Michigan Press, Ann Arbor, Michigan, 1943: 6¾ × 10 in., viii + 78 pp., 1 map. $1.75.

Science is a process of discovering and sorting facts and drawing generalizations from them. New ways of classifying data are always welcome since they may bring to light new scientific principles. Students have proposed various systems for sorting information on the distribution of plant and animal organisms in North America, but only two receive major attention at the present time: the life-zone and the biome systems. In this new book, Dice outlines another scheme of classification, his major units being "biotic provinces," which are subdivided into "biotic districts," "life-belts," and "ecologic associations." A folding map shows the boundaries of the biotic provinces of North America. The book discusses each biotic province in respect to its name, synonyms, boundaries, topography, climate, soil, vegetation, general characteristics of its mammals and birds, and its subdivisions, (though the subdivisions are not worked out completely). Whether or not this system is worthwhile would seem to depend on its being more applicable to the facts than the life-zone and the biome concepts or on its being based on a philosophy so different that new principles are brought to light.

Life-zones are based on the distribution of taxonomic units, chiefly genera and species of animals; biomes on climax plant and animal communities; a biotic province is a "considerable and continuous geographic area . . . characterized by the occurrence of one or more important ecologic associations that differ, at least in proportional area covered, from the associations of adjacent provinces. In general . . . characterized also by peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography, and soil" (p. 3). Actually, however, Dice here bases his classification of biotic provinces "to a very large extent on the vegetation" and there are no long lists given of indicator species of animals, since "available descriptions of the associations of North America are wholly inadequate." In fact, "the limits of geographic range of species and races of plants and animals are not fully satisfactory criteria for determining the boundaries of biotic provinces and districts" (pp. 5–6).

In order that the provinces may fulfill Dice's primary requirement of being "continuous geographic areas" without the interspersion or overlapping of communities usually found in distribution maps of large biota, they are made to include groupings of plants and animals of great diversity. For example, instead of the Carolinian province extending westward into the prairie as tongues of deciduous forest along the rivers, the Illinoian province is made to include both types of vegetation, prairie and oak-hickory forest. Then again, in the mountains a single province may include a whole series of life-belts, for example, the Navahonian province, which includes alpine meadow, subalpine forest, montane forest, chaparral, pinyon-juniper woodland, and arid grassland. On the other hand, some associations usually considered as single units by other ecologists, for example, the mixed prairie, are here divided into as many as four biotic provinces. Although both are professedly based largely on the character of the vegetation, the boundaries of the biotic provinces and those of the biomes or their subdivisions, rarely coincide.

Biotic provinces as a classification are an improvement over life-zones in that the trans-continental belts of the latter are broken up south of the coniferous forests of Canada. Although the Canadian, Carolinian, and Austroriparian provinces show some correlation with the Alleghanian, Carolinian, and Austroriparian faunal areas in the eastern part of the country, there is no such correlation between provinces and the major faunal areas in the west. In mountainous areas, division by life-zones shows the effect of altitude on distribution better than divi-

sion by provinces does, since "life-belts" (more or less comparable with life-zones) are relegated to minor subdivisions of the provinces.

Names assigned to the biotic provinces are taken largely from the literature, mostly but not entirely upon a priority basis. These names go back for their origin to C. Pickering 1830, R. B. Hinds 1843, J. G. Cooper 1859, J. A. Allen 1871, E. D. Cope 1873, E. W. Nelson 1887, while a few are new. For the most part the names are geographical, which is a weakness.

The reviewer believes that while the concept of biotic provinces shows some improvement over life-zones (except when applied to mountainous areas) it is not so flexible nor so usable, nor is it based on such fundamental principles as the biome concept. Furthermore, the criteria used in determining the boundaries of the provinces are often vague, and the nomenclature is cumbersome. Probably no system will come into general and accepted use unless the delimitation of its units and its nomenclature are immediately obvious in the field because based on conspicuous features of the biota.—S. Charles Kendeigh.

THE WILD TURKEY IN VIRGINIA: ITS STATUS, LIFE HISTORY AND MANAGEMENT. By Henry S. Mosby and Charles O. Handley. Virginia Commission of Game and Inland Fisheries, Richmond, Va., 1943: 6 × 9 in., xx + 281 pp., 2 col. pls., 67 figs. $1.00.

This reviewer begins with a distinct bias in favor of the Wild Turkey, and would, had he been contemporary, almost certainly have been in full agreement with Benjamin Franklin's desire to make the Wild Turkey our national bird. It is a real pleasure, therefore, to welcome the first comprehensive monograph which has dealt with all phases of the bird's history, life history, and management. The book is a competent and workmanlike job, and will undoubtedly benefit the object of its study.

Although it deals primarily with the Wild Turkey in Virginia, the volume will have a very much wider application and usefulness. The Turkey ranges throughout Virginia, which is a remarkable epitome of all of eastern United States, since it includes conditions that approach the sub-tropical at the Virginia Capes, has a wide segment of the piedmont, an excellent sample of the ridge and valley province, and, on the Allegheny Plateau, remnants of spruce forest which are near-Canadian. We are given information about the distribution of the bird under this wide variety of conditions.

It is good news that Virginia, despite the age of its settlements, had in 1938, 2,020 flocks of Wild Turkeys, made up of 22,575 individuals. The larger number of the state's counties still have a Turkey population, the heaviest concentrations being on the east slopes of the Blue Ridge. The relationship between extensive forest areas and Turkey populations is clearly brought out; where there are not large forests the birds have not persisted.

The authors have had unusual success in artificial propagation of Wild Turkeys, and they have evolved a number of techniques which are being widely adopted by commercial game raisers. Their discussion of management is, therefore, particularly valuable. The statement, "It has been demonstrated that the Wild Turkey responds to management to a marked degree," is elaborated with suggestions for food plantings, predator and disease control, emergency feeding, refuges, and such matters. The authors are on sound ecological ground when they discuss the management of forests for the Wild Turkey. The book includes a suggested policy and program for Wild Turkey management in Virginia which will be of great value to game commissions of other states.

It is through such monographs as this that game management demonstrates its validity as a field of scientific endeavor. Sound ornithology is supplemented by economic evaluation of an animal in relation to man. Both pure and applied science benefit from this happy combination.—Maurice Brooks.

THE BIRDS OF BRITAIN. By James Fisher. William Collins Sons and Co., London, 1942: 6¼ × 8¾ in., 48 pp., 16 pls. (12 colored) and 22 figs. 4*s.* 6*d.*

James Fisher again shows his unusual ability as an ornithological writer by producing under this well-worn title an original and stimulating little book.

He makes no attempt to provide assistance in the identification of British birds, but wisely confines himself to presenting attractively and compactly an expert's summary of Britain's avifauna, past and present, its peculiar features, the observers (beginning with Matthew Paris in 1251), and finally, an indication of modern trends and probable future developments of bird study in Britain.

The book is illustrated with 38 rather good reproductions (nearly a third of them in color) of bird portraits by some 20 artists, ranging from Daniel King (c. 1652) to A. W. Seaby (1930). The pictures have been ingeniously chosen to both illustrate the text and give a very good insight into the development of bird illustration in Britain.

Any ecologist in this country will read the book with particular interest and will wonder whether our continent too is bound for such drastic and complete alteration of the original landscape as Britain has undergone.

This attractive book will provide Americans who are going to England in such numbers these days with the perspective so invaluable to any bird student when encountering a new avifauna.—J. Van Tyne.

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THE WILSON ORNITHOLOGICAL CLUB LIBRARY

The proposal that the Wilson Ornithological Club establish a library was first made by Frank C. Pellett of Hamilton, Illinois, and was brought before the annual meeting of the Club in Ann Arbor in 1928. A committee consisting of T. C. Stephens, Frank C. Pellett and Myron H. Swenk was appointed to consider the matter, and after two years of study and negotiations an agreement was signed by officers of the Wilson Club and the University of Michigan, establishing the Library in the University Museum of Zoology (*Wilson Bulletin*, 43, 1931:77–78). In a report of the Committee made in March, 1931, a request was made for gifts of reprints, periodicals, books, or entire libraries dealing with ornithology and related subjects; according to the agreement these were to be catalogued, filed, and kept as a unit among the book collections in the Museum. The library was to be open to the staff of the Museum of Zoology and to members of the Wilson Club in Ann Arbor; transportation costs one way were to be paid by the Museum on items borrowed by other members.

The growth of the library has been steady; from a mere yard of books on a shelf, the books and reprints have come to occupy twenty-eight feet of shelf space, and the periodicals about thirty-five feet. Books, reprints, and serials have been contributed; and fifty-five periodicals are currently received as gifts and in exchange for *The Wilson Bulletin*. A catalogue of about two thousand cards covers the main items, and a book plate, designed by George Miksch Sutton, marks each bound volume.

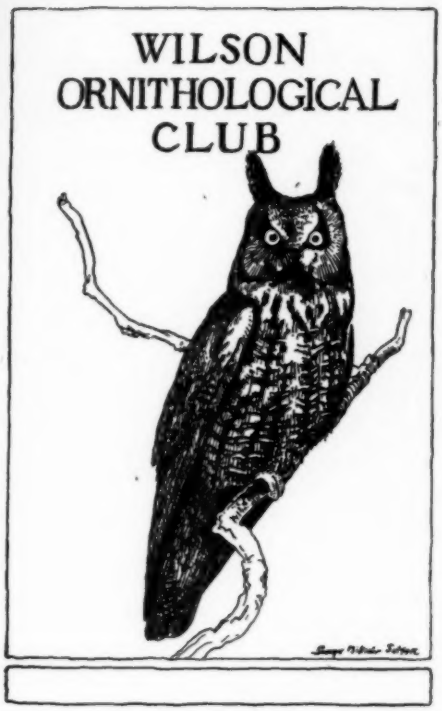
According to agreement, a catalogue (or list) of the items in the Library was to be prepared by the Museum and published by the Wilson Club for the information of the members. Since the manner of listing was a little uncertain, I volunteered to prepare a preliminary list for publication in the *Bulletin*. A complete list of all items, including reprints, would require about forty pages of fine print. Whether this will be prepared later by the Museum and published separately, or in the *Bulletin*, will depend on the wishes of the members, their response to this preliminary list, and the availability of the required funds. To make such a catalogue would require considerable work, and should not be undertaken until normal times, when ample help can be secured. I hope that the present list will be helpful to members in using the library. Members are invited to send inquiries about particular reprints desired, later accessions, or other details. All communications should be addressed to "The Wilson Club Library, Museum of Zoology, Ann Arbor, Michigan."

I hope that contributions to the Library will continue as they have in the past, and I shall be glad to have suggestions from members of the Club concerning the improvement of the Library and its facilities.

LIBRARY COMMITTEE,
Harry W. Hann, *Chairman*

The following gifts have been received recently:

R. M. Barnes: 725 periodicals
Frances Hamerstrom: 37 periodicals
Harry W. Hann: 1 book
Thomas D. Hinshaw: 1 book
Verna R. Johnston: 10 reprints
George A. Petrides: 2 pamphlets
Alma H. Prucha: 34 periodicals
A. W. Schorger: 1 reprint
O. A. Stevens: 3 reprints



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WILDLIFE CONSERVATION

War and Waterfowl

Duck hunting is natural; it is part of our way of life. There is no explaining it, and few hunters could put in words their reasons for wishing to hunt this fall. No explanation is necessary; anyone who has felt a north wind clipping over his left shoulder in a certain hide on a certain marsh understands. But a few duck hunters have become a bit panicky over the prospects of hunting during this year of war. Here are some of the arguments they have given to justify an open season and the use of shells this coming autumn:

1. Duck meat can replace domestic meat in the present meat shortage.
2. Unless we "harvest the crop" there will be an over-population of waterfowl which will:
   (a) exhaust the natural food supply and ruin the range, as over-populations of deer and cattle do;
   (b) become a serious threat to cultivated crops;
   (c) provide an opportunity for the illegal "market hunter" to reestablish himself.
3. Duck hunting would provide a necessary relief for war-torn nerves.

I have no right, of course, to speak of conditions beyond my own bailiwick; my horizon like that of most of us is limited. But my horizon happens to be limited by duck marsh. As far as I can see from my front porch stretches one of the finest waterfowl breeding marshes in the land. I, and the other members of this small marsh-side community, feel a bit closer to ducks, perhaps, than the average sportsman. Ducks are part of our lives, not just for a few days in autumn, but through much of the year. A failure to understand the fascination of ducks and duck hunting does not, therefore, lie at the root of what I have to say for myself and this community in answer to the arguments outlined above.

Wild duck as meat.—I agree that some forms of game should find a place in our war economy, but I do not agree that ducks should be placed on a plane with, for example, deer on an over-populated range. One sporting editor remarks that since duck hunters bag "one duck for every four shells fired, it becomes obvious that they are alleviating the meat shortage at the average cost of about eight cents a pound." Hunters who can bag duck meat for eight cents a pound are few and far between. Dressed for the table, a two pound duck (a good average for mixed bags) weighs one and one-quarter pounds, and provides about a pound of meat (including skin and fat). Shooting dollar-a-box shells, 40 to the bag of ten ducks, the cost of duck meat is sixteen cents a pound in shells alone. But few hunters can shoot ducks on the cost of shells; most must travel a distance to their duck marsh, and the cost in gas, and wear on car and tires is just as much a part of the price of duck meat as brass and powder. Even in this fine duck hunting region duck meat costs the hunter from twenty-five cents to a dollar a pound. Add a guide, club fees, or a rented canoe, as many gunners do, and the cost per pound mounts. Most hunters will admit that duck meat is luxury fare. Whatever the cost per pound may be in dollars and cents (which are plentiful these days) the real cost of wild duck meat is in gas, brass, powder and rubber—all vital war necessities.

The supposed threat of overpopulation.—First, it is true that there has been a general build-up in waterfowl numbers these last few years. To say, however, that failure now to reap the harvest of these gains means destruction of the natural food supply and range is to admit that our restoration program is sadly off balance. Here on the breeding grounds we are still restoring wasted marshlands; we are developing new management techniques; we are controlling the spring fires so disastrous to nesting waterfowl; we are shooting crows wherever

their spring nesting concentrations prove a heavy drain on waterfowl. Have we gone too far in this? Have we already produced more ducks than the country can maintain? The answer is, of course, no. One hears of three-fold and four-fold increases in waterfowl numbers. Increase over what? Isn't it increase over the lowest figure in North American waterfowl history? Populations are still far short of the numbers that poured down the flyways in a not so distant past, even short of the goal set at the beginning of the present restoration program. Among the members of this small marsh community, and they include many duck hunters and guides, there is the general feeling that "this will be a good year for ducks; with the scarcity of shells and fewer hunters, this will be the year ducks can make a real come-back." We say this because we know, despite the annual reports of vast gains, that the marshes reaching from our doorsteps to the horizon are still sadly underpopulated with nesting waterfowl. There are Mallards, yes, and Pintails. But ask anyone on the breeding grounds about the Canvasback, Redhead, Lesser Scaup or Ruddy Duck. They have increased; they have been saved from extinction for the present; but their numbers are still distressingly small and their future uncertain. This prairie marsh, many like it, and still others to be restored could maintain far more breeding ducks than now return each spring from the wintering grounds.

Mallards, Pintails, Black Ducks, and other species in some localities will feed upon cultivated crops this autumn and winter. Even during the years of the "duck depression," damage to grain fields in some localities was a problem. Such farm feeding is not evidence of depleted natural food supplies. In this region, Mallards and Pintails annually feed on stubble fields, despite the fact that their loafing waters provide a plentiful stand of wild duck food. Now, as in the past, this is purely a local problem; it will not be relieved by placing control in the hands of gunners. Crop damage is most serious in a delayed harvest. This year the harvest in some regions will be delayed because of shortage of man-power. If duck hunters truly have the welfare of ducks and crops in mind, they will give their spare time to help with the harvest in regions where there is a combination of man shortage and farm-feeding waterfowl.

I doubt that any force can again bring wild ducks to the market table. There has always been, even during the scarcity of ducks, an underground traffic in wild duck, but the stringent laws and the strong public opinion against the sale of wild ducks are such that talk of the return of the market hunter seems the mere shout of the propagandist, not a valid threat.

Recreational value of duck hunting.—Most of us agree that duck hunting is one of the finest "escapes from the toils of life." But it is doubtful whether the recreational value of duck hunting in war time is worth the cost in time and in essential war materials. Duck hunting as recreation this autumn is a matter for the individual and his conscience. However few or many shells he may be allowed, it is for him to decide how many shells he will use, and how much time he can spare from the task at hand.

* * * *

This last decade has seen a remarkable cycle of events. The danger of the extermination of many duck species was recognized nine or ten years ago. A tremendous effort was then begun in the United States and Canada to restore the dwindling populations, and ducks have since shown encouraging gains. As part of the restoration program, stringent restrictions were placed upon seasons, number taken, and methods of hunting. Some of these have recently been relaxed. There is now pressure for further relaxation—for longer seasons, bigger bags, for the return of live decoys and baiting, and for the opening of refuges to shooting. Such demands are a natural accompaniment to the up-swing in waterfowl numbers. But these demands are coming while we are at war, and I doubt whether there

are hunters and shells enough to constitute any serious present threat to waterfowl. The real threat is not in the number of ducks which might be shot this autumn but from war-time changes in policy which might seriously affect ducks in a post-war world.

As this issue of the *Wilson Bulletin* appears, the regulations for the new season are on paper. We have confidence in those who plan them. We are content to count officialdom among our members, as indeed it is; yet if we as ornithologists fail to put forward sound, democratic opposition to the sportsman pressure groups, we are no less responsible for imprudent changes in policy than the groups which forced them through. It is our responsibility, individually and collectively, to keep informed on the waterfowl situation just as we keep up to-date on developments in nomenclature or life history study. And it is our obligation through the remaining years of war and after the war to take an active part in the planning and maintaining of sound waterfowl policy.—Albert Hochbaum.

WILDLIFE CONSERVATION COMMITTEE
Frederick N. Hamerstrom, Jr., *Chairman*

REPORT OF THE AUDITING COMMITTEE

The Auditing Committee has checked the accounts of Gustav Swanson, Treasurer of the Wilson Club for 1942, and the financial report published in *The Wilson Bulletin* for March, 1943, and hereby expresses its approval of the state of these accounts.

Respectfully submitted,
CHARLES F. WALKER
August 12, 1943 THOMAS H. LANGLOIS

AFFILIATED SOCIETIES

We are glad to report that the Wisconsin Society for Ornithology has recently voted to affiliate with us, and we hope to have an account of their organization in a later issue.

An increasing demand for news of the affiliated societies has come from the Wilson Club membership. Suggestions and data should be sent to Dr. Gordon M. Meade of Rochester, New York, Chairman of the Committee on Affiliated Societies. We present below brief accounts of the history and aims of the Virginia Ornithological Society and the Inland Bird Banding Association.

THE VIRGINIA SOCIETY OF ORNITHOLOGY was founded in December, 1929. Because of transportation difficulties the annual meeting was not held in 1942, and it is doubtful, for the same reason, whether it can be held this year. Activities therefore, have centered around the publication of the mimeographed bulletin *The Raven*, and the Society has such an enthusiastic group of members that the cancellation of the annual meeting has had no serious effects. Local groups in such cities as Norfolk, Richmond, and Roanoke continue to get together for meetings and for field trips.

The officers of the Society are: President, A. O. English, Roanoke; Vice-president, William B. McIlwaine Jr., Petersburg; Secretary, Dr. Florence S. Hague, Sweet Briar; Treasurer, T. L. Engleby, Roanoke.

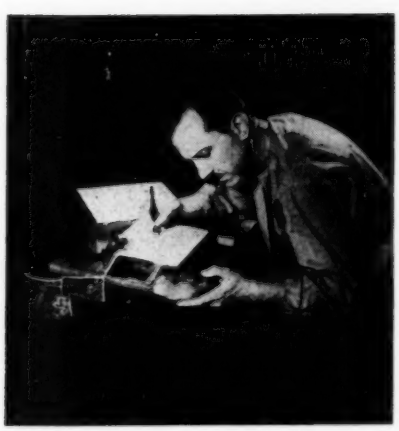
In spite of the fact that bird observation in Virginia goes back through three centuries, only certain small areas of the state have been thoroughly worked. There is a great deal still to be learned about distribution in Virginia—even of some of the more common birds—and the chief task which the Society of Ornithology has set itself is the gathering of data on which an accurate and comprehensive publication on the birds of Virginia can be based.—Florence S. Hague, Secretary.

THE INLAND BIRD BANDING ASSOCIATION held a meeting in conjunction with the Wm. I. Lyon Bird-banding Council at the Chicago Academy of Sciences on March 20, 1943. A full day and evening program on bird banding and other bird studies was given. The following officers were elected: president, C. C. Ludwig, Lansing, Michigan; vice-president and treasurer, M. J. Magee, Sault Ste Marie, Michigan; vice-president, Philip A. DuMont, Evanston, Illinois; vice-president, Paul A. Downing, Highland Park, Illinois; secretary, O. A. Stevens, Fargo, North Dakota.

A history of the Inland Association was published in the *Wilson Bulletin* for September, 1940. A news letter, *Inland Bird Banding News,* issued quarterly since 1929, was last year changed to a bi-monthly. Arrangements have been made with the Eastern Bird-banding Association whereby members of each association receive the news letters of both organizations. One feature of the *Inland News* during the past two years has been a series of summaries of the progress of banding in the various states of the Inland region.—O. A. Stevens, Secretary.

NEW LIFE MEMBERS

MYRON T. STURGEON became interested in birds while an undergraduate at Mount Union College, Alliance, Ohio. He majored in geology and paleontology, receiving the Ph.D. from Ohio State University in 1936. He is at present assistant professor of geology at Michigan State Normal College, Ypsilanti, where he gives courses in ornithology as well as in geology and general zoology. During the summers he assists with the class in Game Ornithology given by the Michigan Department of Conservation Training School at Higgins Lake, and serves as assistant geologist for the Geological Survey of Ohio.



GEORGE MIKSCH SUTTON graduated from Bethany College and received the Ph.D. from Cornell University. He was Assistant Curator of Birds at Carnegie Museum 1919–1924, and State Ornithologist of Pennsylvania 1925–1929. He has been a very active field man and has published many papers on the life histories, plumage, and taxonomy of birds, based on the data gathered during his expeditions to widely separated localities from northern Hudson Bay to southern Mexico. He is, of course, not only an ornithologist, but an outstanding painter of bird pictures. He has been Curator of Birds at Cornell since 1932 and is now on leave of absence serving as Captain in the U. S. Army Air Corps.

TO OUR CONTRIBUTORS

Our members are asked to submit articles for publication in the *Bulletin*. Manuscripts will be accepted with the understanding that they have not been published or accepted for publication elsewhere.

MANUSCRIPT. Manuscripts should be typed on paper of good quality and of letter size (8½ x 11). Write on one side only and use double spacing. The title should be brief and carefully constructed so as to indicate the subject clearly. Ordinarily the scientific names of the birds treated should be given and should appear early in the article. Most articles should have a brief summary at the end.

BIBLIOGRAPHY. Literature referred to in the text should be cited by author's name, year of publication, and exact pages of the particular reference. Such citations should ordinarily be listed in full at the end of the paper.

ILLUSTRATIONS. Photographic prints, to reproduce well as half-tones, should have good contrast and detail. Please send prints unmounted, and attach to each print a brief but adequate legend. Do not write heavily on the backs of photographs.

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